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Truck-Mixed Concrete for Paving Boston-Worcester Turnpike

Road Builders' Number

- Bituminous retread-penetration surfacing at low cost
- Stop-watch studies to reduce paving delays
- Lowering road construction costs with lean-mix concrete
- Details of highway maintenance and construction
- Truck haulage on sand-asphalt paving contracts
- Construction at intersections to unscramble traffic
- Brick paving on concrete base
- Truck haulage

105
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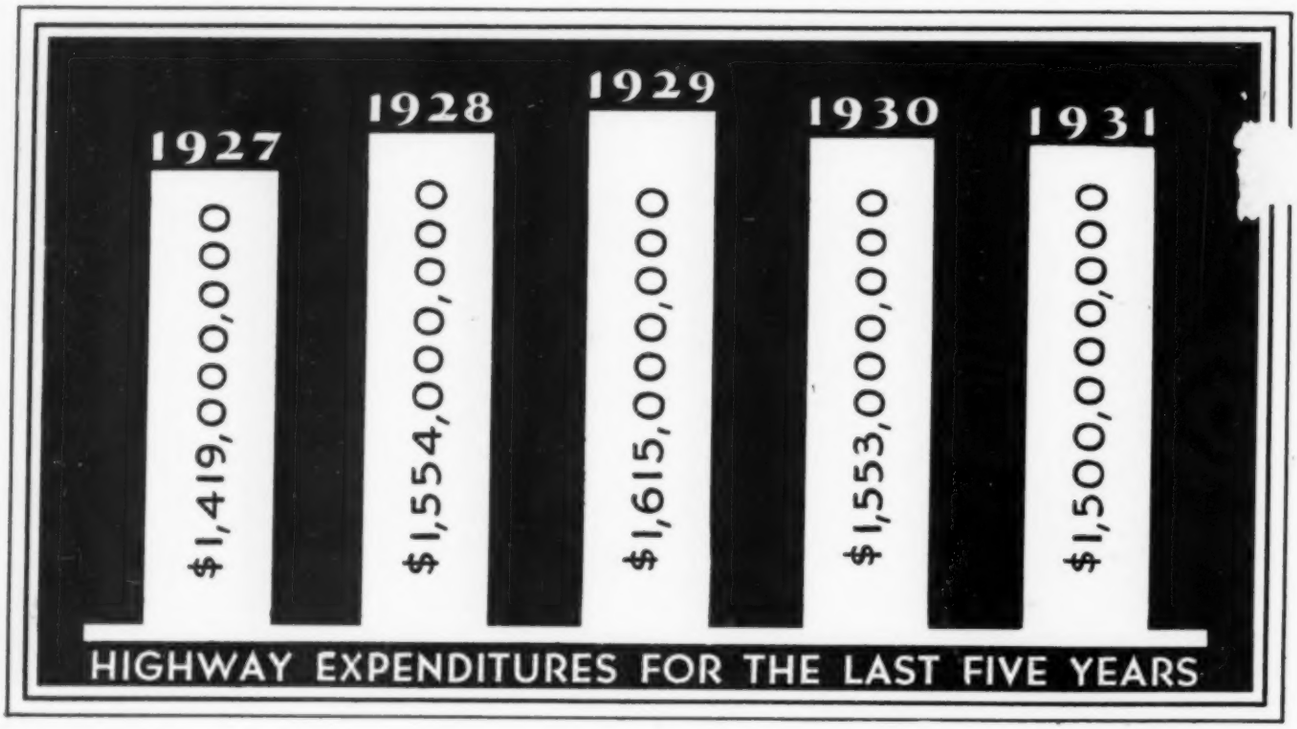
CONTINUING *the Campaign for* BETTER HIGHWAYS . . . . .



DURING the year just closed, at least one and one-half billion dollars were spent on highway programs, giving employment directly to 1,000,000 men and indirectly, through the manufacture of materials and equipment, to 2,000,000 more.

One result of the recent business depression, too easily overlooked, has been the Government's active support and encouragement of Good Roads projects. It has been responsible for the construction and reconstruction of many added miles of good roads and has created jobs for 3,000,000 workers. This is reflected in better transportation facilities.

The Metropolitan Paving Brick Company is devoting the full power of its manufacturing resources and its engineering skill to the betterment of road conditions and improvement of the nation's transportation system — to meet the heavy demands which pleasure and commerce will put upon it this year. Through its national advertising and radio broadcasting, Metropolitan is conducting a public campaign to promote the construction of better highways.

Modern Brick Surfaced pavements pay increasing dividends in satisfaction to the individual motorist and in public confidence.

THE METROPOLITAN PAVING BRICK CO.
CANTON, OHIO

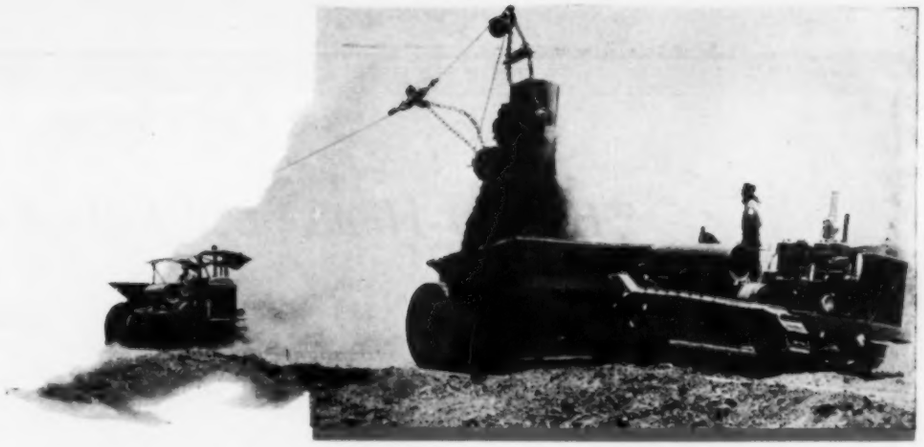
Manufacturers of Metro Canton, Bessemer, Olean, and Cleveland Paving Block • Architectural Face Brick Structural Clay Tile • Metro Trickling Filter Flooring

BRICK PAVEMENTS

CONSTRUCTION METHODS, January, 1932. Vol. 14, No. 1. Published monthly. McGraw-Hill Publishing Company, Inc., 330 West 42d Street, New York, N. Y. $1 per year. Foreign Postage, $1.00. Canada (including Canadian duty), $1.50. 10 cents per copy. Entered as second-class matter, October, 1926 issue. Vol. 8, No. 19, at the Post Office at New York, N. Y., under the Act of March 3, 1879. Printed in U. S. A.

Tech.

The Editor Notes -



Paving With Truck-Mixed Concrete

A SIGNIFICANT development in paving practice during 1931 was the increased use of truck-mixed concrete. Until fairly recently it was unusual to see a concrete highway built by any other method than the one using concrete produced by a crawler-mounted paving mixer operating on the subgrade. In Massachusetts last season, however, sections of the concrete super-highway known as the Boston-Westchester turnpike described in detail on pp. 28-33 were built with concrete mixed on trucks in transit between a central batching plant and the subgrade.

For the truck-mixer method, the outstanding advantage claimed is the elimination of the production "bottleneck" created by the fixed time cycle on which the paving mixer must operate. With a specified mixing time of 1¼ min. per batch, the maximum possible output of the standard 27-E paver is forty 1-yd. batches per hour. With a fleet of truck mixers, on the other hand, no such limit on production prevails. As many batches per hour can be placed as the spreading and finishing crew can handle. With an adequate fleet of trucks the mixing operation ceases to be the controlling factor in concrete production, and the batching plant becomes the pace-setter on the job. Another important element contributing to increased output is the larger size of the truck-mixed batches—3½ cu.yd. —as compared with the paver-mixed batches of 1 cu.yd.

To be weighed against the advantages of the truck-mixer method of concrete paving is the larger initial outlay for equipment. Obviously, the job must be of sufficient size to absorb this increased first cost of plant.

Methods of Installing Slab Reinforcement

A perfect method of installing steel reinforcement in concrete slab, without detriment to the concrete and without delay to paving operations, has yet to be discovered. Present practices are weak in either one respect or the other. Apparently the method most favored by designers and inspectors today is that of striking off a bottom layer of concrete, placing the steel reinforcement, and covering with a top layer of concrete. This procedure causes loss of time, particularly when the mixer is operating on a short cycle.

On pp. 35-37 of the November issue was described a method tried in Kansas of supporting wire-mesh reinforcement on steel sleds attached to the paver. The reinforcement was laid on the sleds before any concrete was dumped, and the method was intended to eliminate time and labor lost in striking off a bottom layer of concrete. Special precautions were taken to prevent the formation of voids and planes of weakness in the concrete.

Since the publication of this article, W. V. Buck, state highway engineer of Kansas, has written to report that the use of the sled to support wire-mesh reinforcement has proved impracticable. A number of cores taken from the job described and from two short projects built this year show some evidence of voids at the points where the sleds were pulled through the concrete. Kansas has discontinued the use of sleds in placing wire-mesh reinforcement in concrete slab.

Because the ideal method is still being sought, the Bureau of Public Roads has generally accepted the practices of the respective state highway departments in regard to the method of supporting steel reinforcement while concrete is being placed. As one of the articles in this issue indicates, a shortening of mixing periods to 50 or 60 sec. may be expected. This shortening will make more serious the delay caused by the usual method of striking off a bottom layer of concrete and will place a larger share of the cost on this operation. Opportunity exists for thoughtful road builders to evolve a method of handling the steel reinforcement which will be quick, accurate, and trustworthy.

Annual Road Builders' Issue

Appearing, as usual, on the eve of the convention and show, at Detroit, of the American Road Builders' Association, this issue of *Construction Methods* is its annual Road Builders' number. The pages that follow indicate, in text and illustration, what the year 1931 has contributed, in better methods and improved equipment, to the progress of highway construction. During a year of world-wide depression in industry, the march of the road builders has been forward.

COMING
Next Month

J. I. Ballard, assistant editor of *Construction Methods*, recently returned from a visit to the Hoover Dam on the Colorado River. His description of construction activities now in progress to provide for the job personnel by building Boulder City in the Nevada desert will be the feature of next month's issue.

CONSTRUCTION METHODS
A monthly review of modern construction practice and equipment

ROBERT K. TOMLIN, *Editor*

Editorial Staff

VINCENT B. SMITH NELLE FITZGERALD
J. I. BALLARD (San Francisco)

WILLARD CHEVALIER, *Publishing Director*

McGraw-Hill Publishing Company, Inc.
330 West 42d St., New York, N. Y.

Construction Methods was founded in 1919, under the name *Successful Methods*, by the Manufacturers Publicity Bureau, Inc., of Chicago, representing a group of non-competing manufacturers of construction equipment. Charles R. Thomas, editor of the first few issues, was succeeded by William Jabine.

In 1926 the McGraw-Hill Publishing Company, Inc., of New York, purchased the publication, changing its name to *Successful Construction Methods* in November of that year and to *Construction Methods* in May, 1927.

Robert K. Tomlin was appointed editor of *Construction Methods* in January, 1928. Vincent B. Smith and J. I. Ballard (San Francisco) are assistant editors and Nelle Fitzgerald editorial assistant.

"Buy-at-Home" vs "Sell-at-Home."

OF all the economic factors that have contributed to the growth and welfare of the United States, two are paramount: (1) The widespread application of mechanical power, which has multiplied so effectively the earning power of the individual. (2) The fact that our country is one economic unit, which has insured a nation-wide freedom of exchange and given to every community and every producer free access to a vast market for their products.

It is understandable that in a time of stress and discouragement the average citizen should forget these elementary truths. It is natural that under the pressure of local distress he should be tempted to seek relief at a price far greater than may appear on the surface. But it is pathetic when political and business leadership fails to guard him against such temptation.

Last month on this page *Construction Methods* commented briefly on the fallacy of substituting hand-labor for mechanical power as a measure of unemployment relief. No less unfortunate is the policy now prevailing in some states of restricting the use of materials for public works to those produced within those states. As the hand-labor fallacy tends to nullify one of our sources of strength, the buy-at-home fallacy undermines the other.

In appraising the buy-at-home proposal, the thoughtful citizen will consider these points:

1 A major cause of the higher standards of wages and living in the United States as compared with the rest of the world, even under present conditions,is the free interchange of goods and services between all its parts, thereby putting both the products and the buying power of all at the service of each.

2 The constitutional provisions against restraint of trade between the states recognize this; they were written after destructive trade rivalries between the colonies had proved the folly of home-trade measures such as are now invoked in principle by some of the states.

3 The logical outcome of "buy-at-home" is "sell-at-home", for discrimination against outside products breeds retaliation. But no state can live unto itself without outside markets for its products. In order to create a monopoly for a few of its citizens the state risks destruction of the markets upon which the bulk of its people must rely for their living.

4 If the several states had been permitted to operate during the years on the home-buying principle now espoused by some of them, there would have been no mass production, no national distribution of commodities, no efficient organization of industry, no national industries. We should now have but frail arteries of communication and transportation, and many states would be throttled in the grip of self-created monopoly.

No other industry is more nation-wide in its scope or more diversified in its requirements of materials and equipment than is the construction industry. It stands to suffer most heavily were such policies carried to their logical conclusion. It should not be misled into acceptance of destructive doctrines, however alluring they may seem to the individual at the moment. The chickens of trade discrimination always come home to roost.

Willard Chevalier

Publishing Director.

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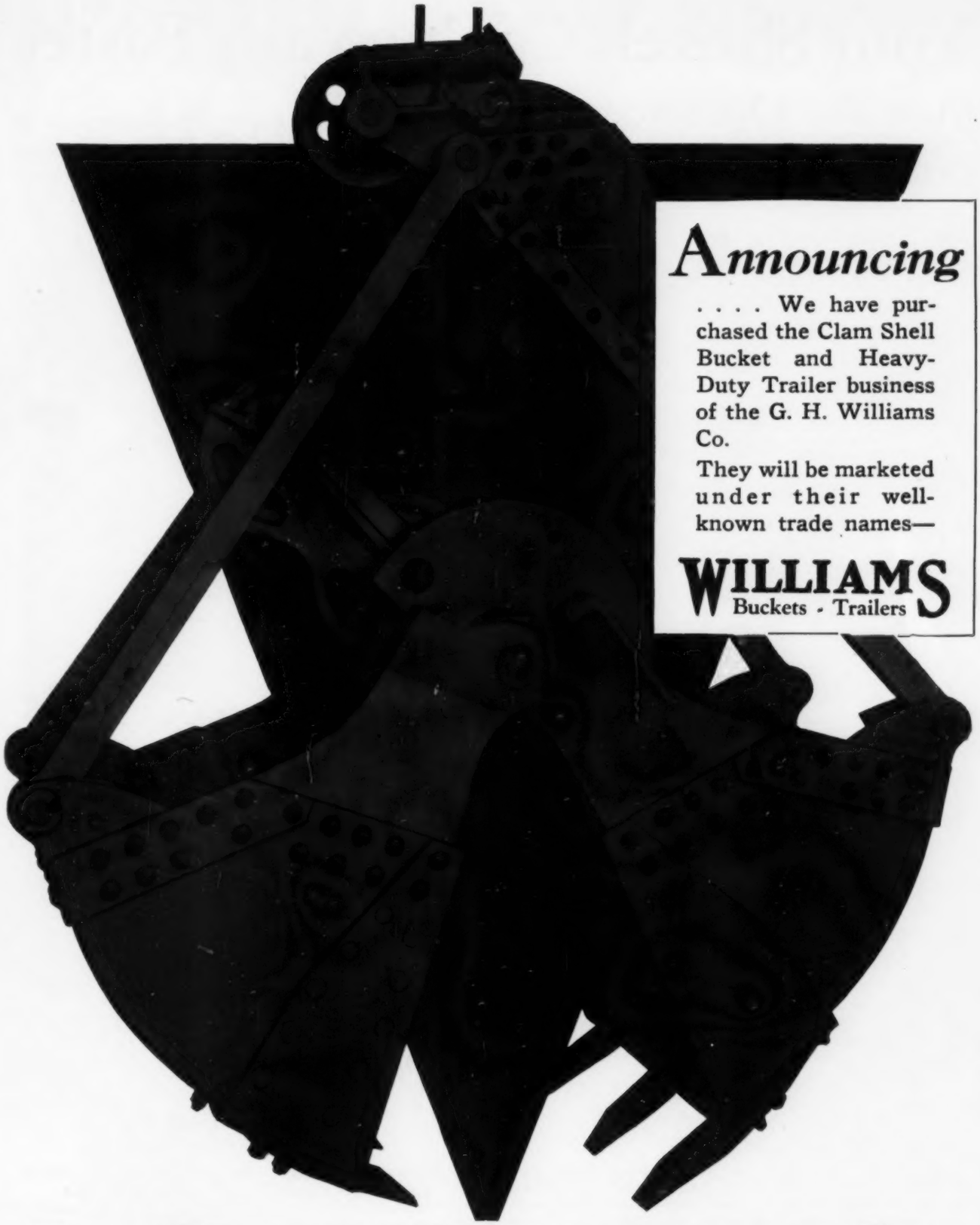

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. . . . We have purchased the Clam Shell Bucket and Heavy-Duty Trailer business of the G. H. Williams Co.

They will be marketed under their well-known trade names—

WILLIAMS
Buckets - Trailers

THE WELLMAN ENGINEERING CO.

ENGINEERS CONSTRUCTORS MANUFACTURERS

CLEVELAND, OHIO

New York City: 30 Church St. • Chicago: Room 401 at 549 West Washington Blvd. • Birmingham: 1101 Webb Crawford Bldg.
"Canadian Wellman-Seaver-Morgan Co., Ltd.," 307 Reford Bldg., Toronto: 821 Castle Bldg., Montreal
Mexico City: Edificio Oliver, 16 De Septiembre No. 5.

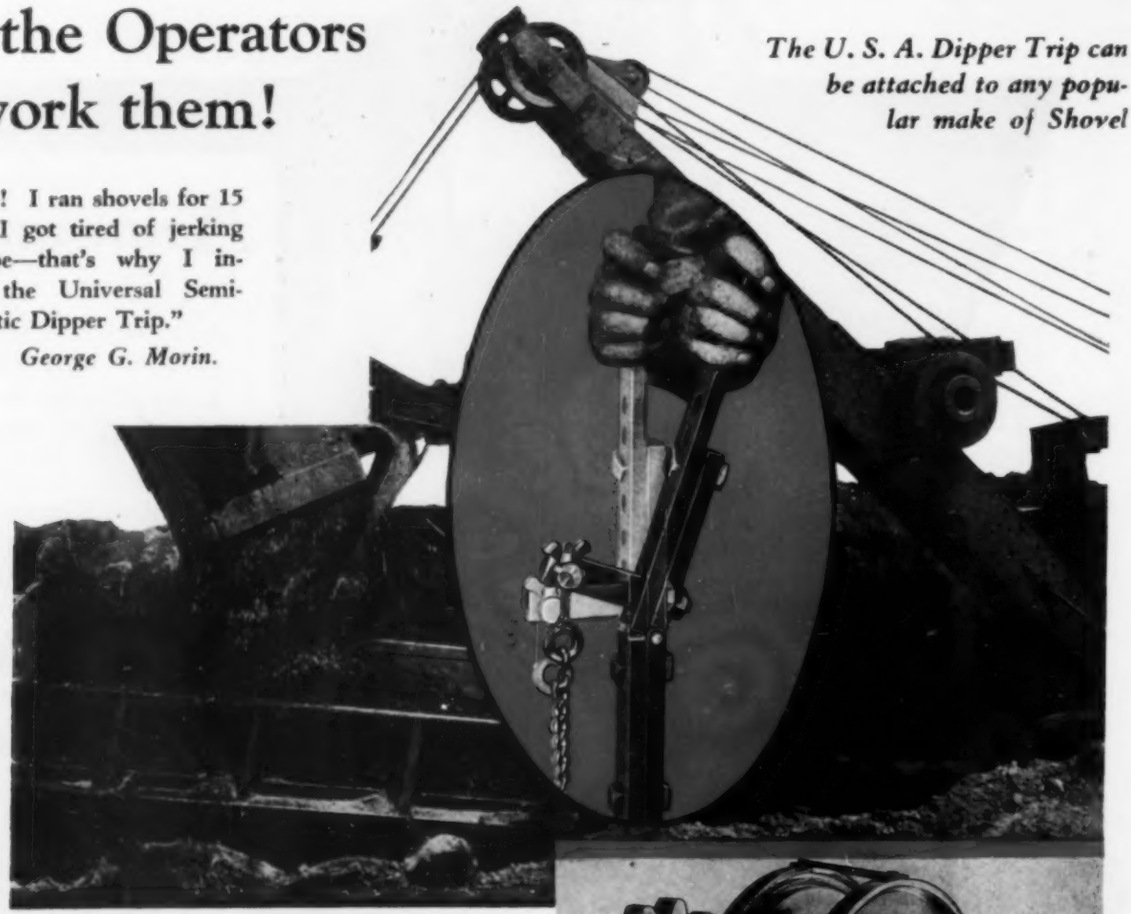
Your Shovels Can't go any Faster

than the Operators can work them!

The U. S. A. Dipper Trip can be attached to any popular make of Shovel

● "I know! I ran shovels for 15 years. I got tired of jerking the rope—that's why I invented the Universal Semi-Automatic Dipper Trip."

George G. Morin.



The Universal Semi-Automatic Dipper Trip

Will add 10% to the yardage of every power shovel (1) By speeding Trip Action (2) Eliminating lost motion (3) Conserving operator's energy.

How It Works. The dipper tripping control is made a part of one of the regular operating levers. The operator doesn't have to take his hand off the lever. With a twist of the wrist, he bends the handle to the left and trips the bucket instantly.

The most profitable piece of equipment you can install on your power shovel. Will pay for itself in a very short time.

This simple device is being used by many of the leading contractors and road builders throughout the country—among which are:

Lane Construction Corp., Meriden, Conn.
S. J. Groves & Sons, Minneapolis, Minn.
New Haven Road Construction Co., New Haven, Conn.
Fitzgerald Bros., Troy, N. Y.
Dan O'Connell's Sons, Inc., Holyoke, Mass.
A. I. Savin, Hartford, Conn.
Central Maine Power Co., Augusta, Me.
John Arborio, Inc., Poughkeepsie, N. Y.

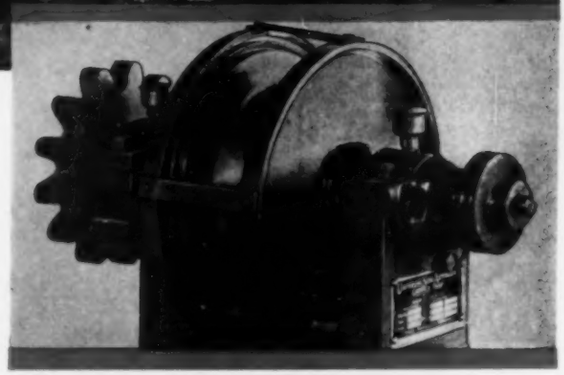
Other Features:—It will not only trip a shovel dipper, but also a skimmer scoop and a pull shovel—without making any changes.

It can also be used as a Tag Line Winder on clamshell work. The only change necessary is to replace trip cable with a longer line. This gives operator complete control of bucket and speeds up work.

Write for full details and cost. Specify make and size of shovels used.

Morin Mfg. Co.

HOLYOKE, MASS.



Universal Semi-Automatic Dipper Trip. This type is for Northwest 104 and 105, and the Osgood Conqueror.

Optional—*at extra cost on*

- Marion Shovels
- Byers Shovels and Cranes
- P & H Shovels and Cranes

Other shovel manufacturers will equip new shovels with these "Dipper Trips", when requested.

MORIN MFG. CO., Holyoke, Mass.
We'd like to know more about the U. S. A. Dipper Trip for

.....Shovel, Model.....

Signed .....

Company .....

Address .....

.....

NORTHWEST
the STANDARD
toward which
others
build

THERE have been no old beliefs or traditions to retard the progress of Northwest design. Northwest's claims to leadership are based on the number of practical achievements offered to the industry, not on the number of years in business.

Six years ago Northwest was offering many of the features only recently offered by other manufacturers. Northwest was first to use a heavy duty, slow speed engine designed especially for excavator service.

—first to offer a successful oil engine for excavator service.

—first with a high quality main drive, comparable to the best speed reducers—helical gears mounted on ball and roller bearings and running in oil.

—first with the only real crawler steering mechanism, controlled from the cab and assuring positive traction on both crawlers even while turning.

—first with the "feather-touch" control, the first power clutch control ever installed on a shovel or crane.

—first to use ball or roller bearings on all high speed shafts.

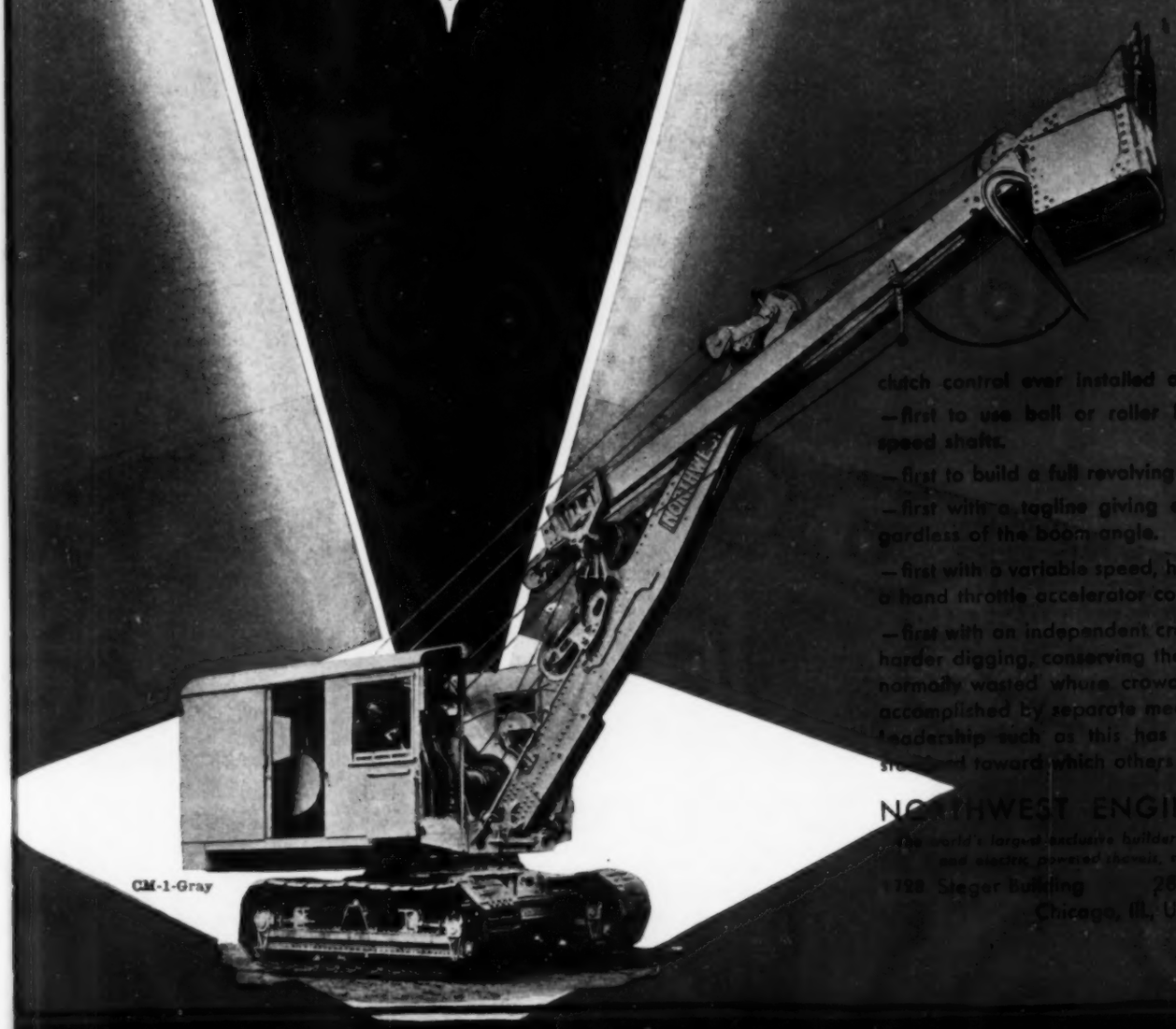
—first to build a full revolving pullshovel.

—first with a tagline giving efficient operation regardless of the boom angle.

—first with a variable speed, heavy duty engine with a hand throttle accelerator control.

—first with an independent crowd that handles 25% harder digging, conserving the 25 to 30% of power normally wasted where crowding and hoisting are accomplished by separate mechanisms.

Leadership such as this has made Northwest the standard toward which others build.



CM-1-Gray

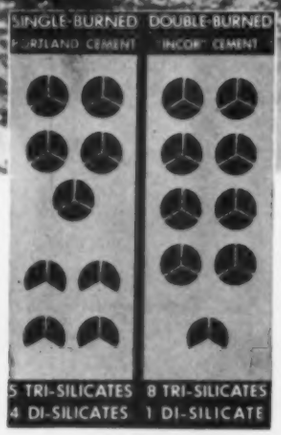
THIS IS PAG 5

NORTHWEST ENGINEERING CO.

The world's largest exclusive builders of gasoline, oil burning and electric powered shovels, cranes and draglines

1198 Steger Building 28 E. Jackson Boulevard
Chicago, Ill., U. S. A.

"If I'm any judge,



"THIS IS THAT '*INCOR*'." Drillers cutting a 6" core from a highway. A re-enactment of the scene described on the next page which took place on the Blue Mound Road in February, 1929. The 'Incor' cores drilled that day and tested by the Highway Department developed an average compressive strength at 6 months of 5524 pounds per square inch.

THE CHEMISTRY OF 'INCOR'S' TOUGHNESS. (Left) This diagram illustrates the difference in chemical constitution between ordinary Portland Cement and 'Incor' Portland Cement. Each complete circle symbolizes a molecule of *tri*-calcium silicate, which is active and combines easily and thoroughly with water. Each incomplete circle symbolizes a molecule of *di*-calcium silicate which is sluggish and combines slowly. This greater refinement is achieved by 'double-burning,' an exclusive 'Incor' feature.

this job's going to be here a *long time*"

Driller's opinion confirmed as 24-hour concrete is tested at six months and three years

A DRILLER'S remark in February, 1929, as he was cutting a core out of the Blue Mound Road at Greenfield Avenue in Wauwatosa, Wisconsin, was certainly prophetic.

This intersection had been paved six months before, under interesting circumstances. At that time, the Wisconsin Highway Department was supervising the paving of the Blue Mound Road on the outskirts of Milwaukee.

Managers of important industries in the neighborhood realized that their trucking operations would be seriously interfered with if they had to wait the usual one or two weeks for the concrete to harden.

They brought the matter to the attention of the Highway Department's Engineers. As a result, 'Incor' 24-hour cement was used at both the Cottrell and Greenfield Avenue intersections. The day after the concrete was placed these intersections were open to traffic.

THE NEW PAVEMENT. A section of the Blue Mound Road in Wauwatosa, Wisconsin, which was paved with 'Incor' in August, 1928, and opened to traffic 24 hours after being poured. Cores drilled from the 'Incor' pavement at 3 years developed an average ultimate strength of 7395 pounds per square inch.

Six months passed. Then one day the Highway Department drillers came to cut the usual test cores from the highway.

When they tackled the 'Incor' concrete, the cutting proceeded at a much slower rate than usual, and the exceptional toughness of the concrete became evident.

"*If I'm any judge, this job's going to be here a long time,*" said the driller.

Four cores, six months old, were cut from the 'Incor' concrete that day. Tested by the Highway Department, they revealed the following ultimate strengths: 6180, 5545, 4725, and 5645 pounds per square inch—an average of 5524. To engineers, such figures speak for themselves.

Second Set of Cores Cut

These remarkable results raised the question: "What will the strength of this concrete be later on?"

Accordingly, on August 14, 1931, three years to a day after the concrete was laid, additional cores were drilled from the 'Incor' pavement.

Tested in Chicago, in the presence of public officials, these cores revealed the following strengths: 7264, 6538, and 8384—*an average of 7395 pounds per square inch.* This represents a strength-increase of almost 2000 pounds per square inch over the six months' average.

Such remarkable results are understandable when it is remembered that the high *early* and extremely high *ultimate* strengths of 'Incor' cement are both achieved by the same means, not by admixtures or increased proportions of cement but by the 'double-burning' of the original product—an exclusive 'Incor' feature.

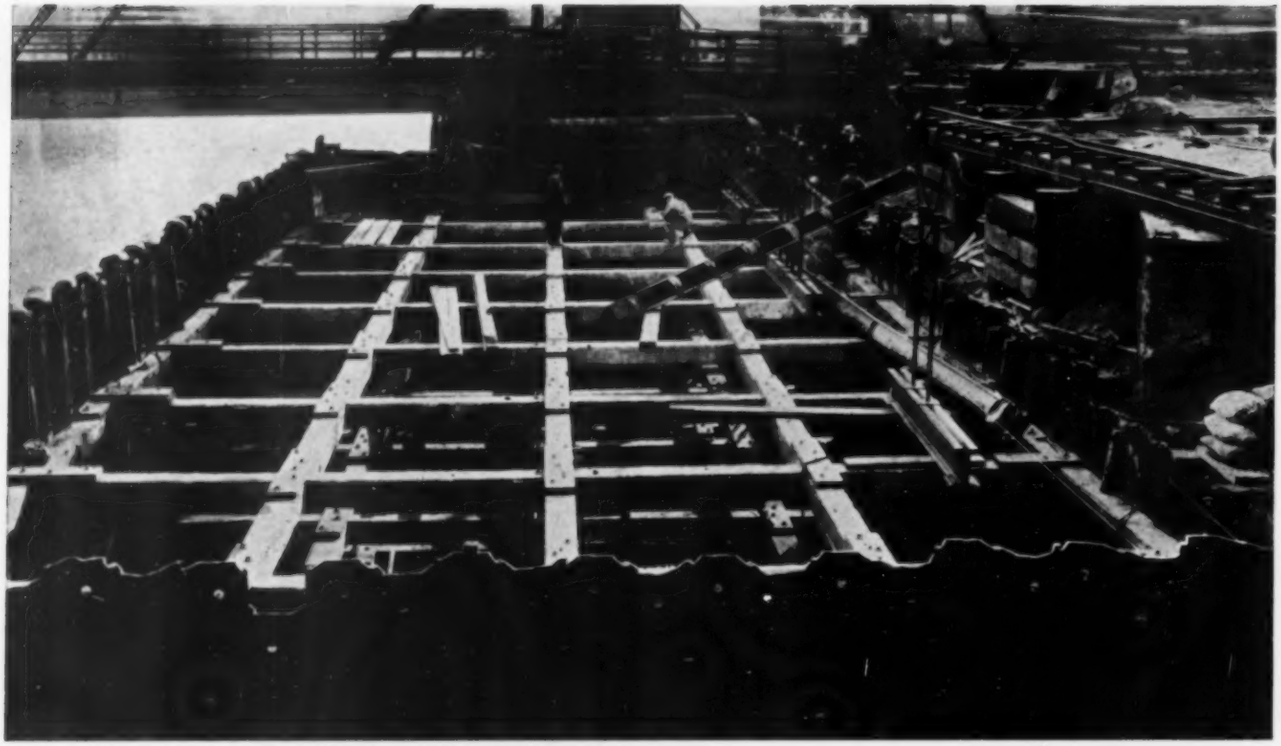
The national success of 'Incor'* is reflected in its price. When the above job was laid 'Incor' cost nearly twice as much as ordinary Portland cement. Today the difference in cost is a mere fraction of the savings it provides.

* Reg. U. S. Pat. Off.

'INCOR' *24-Hour Cement*

MANUFACTURED BY THE 'DOUBLE BURNING' PROCESS

'INCOR' Cement is made by the producers of Lone Star Cement, under basic patents owned by International Cement Corporation, New York City



LACKAWANNA PILING

used in construction of Metropolitan Ave. Bridge, Brooklyn

This 90 x 38 ft. single-wall cofferdam for one of the piers of the Metropolitan Avenue Bridge over English Kills, Brooklyn, was built of Lackawanna Sections DP165 and AP14 in 42-ft. lengths. Section DP165 was used for the channel side and ends; Section AP14 was used for the shore side on account of the possibility of striking obstructions in driving.

After first placing the two top tiers of bracing, held in place by timber guide-piles, the sheet piling was driven to an average depth of 39 ft. below mean high water. The cofferdam was excavated, the timber-bearing piles driven, and the concrete seal placed. The cofferdam was then unwatered and the remaining tiers of bracing were installed.

On unwatering it was disclosed that the Section AP14 Piling had been driven through 24 in. of timber at several places and had penetrated some old wood piles, splitting them in two.

It took approximately 7 hrs., using two centrifugal pumps, to pump the cofferdam dry to the top of the seal, 21 ft. below water level. After unwatering, one small pulsometer pump kept the cofferdam entirely dry.

Contractors—E. O. Roberts Company, Inc., New York City

BETHLEHEM

BETHLEHEM STEEL COMPANY
General Offices: Bethlehem, Pa.

District Offices: New York, Boston, Philadelphia, Baltimore, Washington, Atlanta, Pittsburgh, Buffalo, Cleveland, Cincinnati, Detroit, Chicago, St. Louis, Houston, Dallas.

Pacific Coast Distributor: Pacific Coast Steel Corporation, San Francisco, Los Angeles, Portland, Seattle, Honolulu.

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SPEED

SPEED for the hardest driven jobs of 1932.

But not speed alone. Bucyrus-Eries have *speed—power—dependability*—to a degree that gives you new ideas about the meaning of "1-yard" or any other rated capacity . . . You owe it to yourself to investigate Bucyrus-Eries before you buy.

BUCYRUS-ERIE COMPANY, South Milwaukee, Wisconsin

Branch offices and service stations in principal cities.

BUCYRUS
ERIE

CONTRACTORS SHOVELS

Gasoline — Diesel — Electric

21-B 3/4-yd. 32-B 1-yd. 37-B 1 1/4-1 1/2-yd.
43-B 1 1/2-1 3/4-yd. 52-B 2 1/4-yd.

CONVERTIBLE SHOVELS — DRAGLINES — CLAMSHELLS — LIFTING CRANES A-433

It pays to deal with Blaw-Knox

WAGON GRADERS

HYDRAULIC SCRAPERS

DRAGLINE BUCKETS

ROAD FORMS

ORD ROAD FINISHERS

STEEL FORMS FOR GENERAL CONSTRUCTION

STEEL FORMS FOR STREETS AND SIDEWALKS

BULK CEMENT PLANTS

FOR twenty-five years the construction industry has depended upon Blaw-Knox for many items of equipment to make work easier, more precise, and less costly. Blaw-Knox has successively developed new machinery in anticipation of each new trend in construction. It is constantly developing new ideas and improvements.

Blaw-Knox makes equipment to do the work, not to meet a price, although thousands of users know that Blaw-Knox Products are priced reasonably.

The complete line of Blaw-Knox Construction Equipment includes:—

- Batcherplants—Steel Bins
- Road Forms
- Clamshell Buckets
- Bulk Cement Plants
- Wagon Graders
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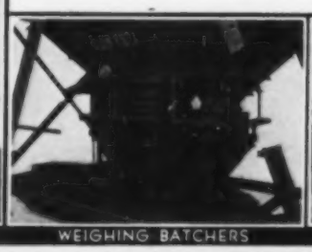
- Truck Turntables
- Water Measuring Tanks
- Agitator Truck Bodies—Open Type
- Weighing Batchers
- Ord Road Finishers
- Dragline Buckets
- Cementanks
- "Ateco" Hydraulic Scrapers — Bulldozers, Scarifiers and Tamping Rollers.
- Trukmixers and Closed Type Agitators
- Steel Forms for Streets and Sidewalks
- Steel Forms for General Construction.

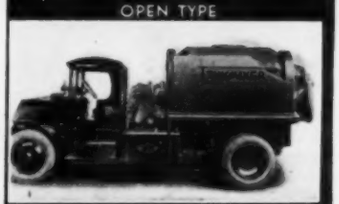


WEIGHING BATCHERS

BATCHERPLANTS

CLAMSHELL BUCKETS

AGITATOR TRUCK BODIES OPEN TYPE



TRUKMIXERS AND CLOSED TYPE AGITATORS

READY MIXED PLANTS

BLAW-KNOX

2086 Farmers Bank Bldg., Pittsburgh, Pa.

New York, Chicago, Buffalo, Philadelphia, Birmingham, Cleveland, Detroit, Baltimore

Export Division:
Blaw-Knox International Corporation,
Canadian Pacific Bldg., New York

London, England, New Oxford House, Hart St., Holborn W. C. 1.—Paris, France, 1 Rue de Clichy —Milan, Italy, 6, via S. Agnese, 6—Dusseldorf, Germany, 17 Bismarckstrasse

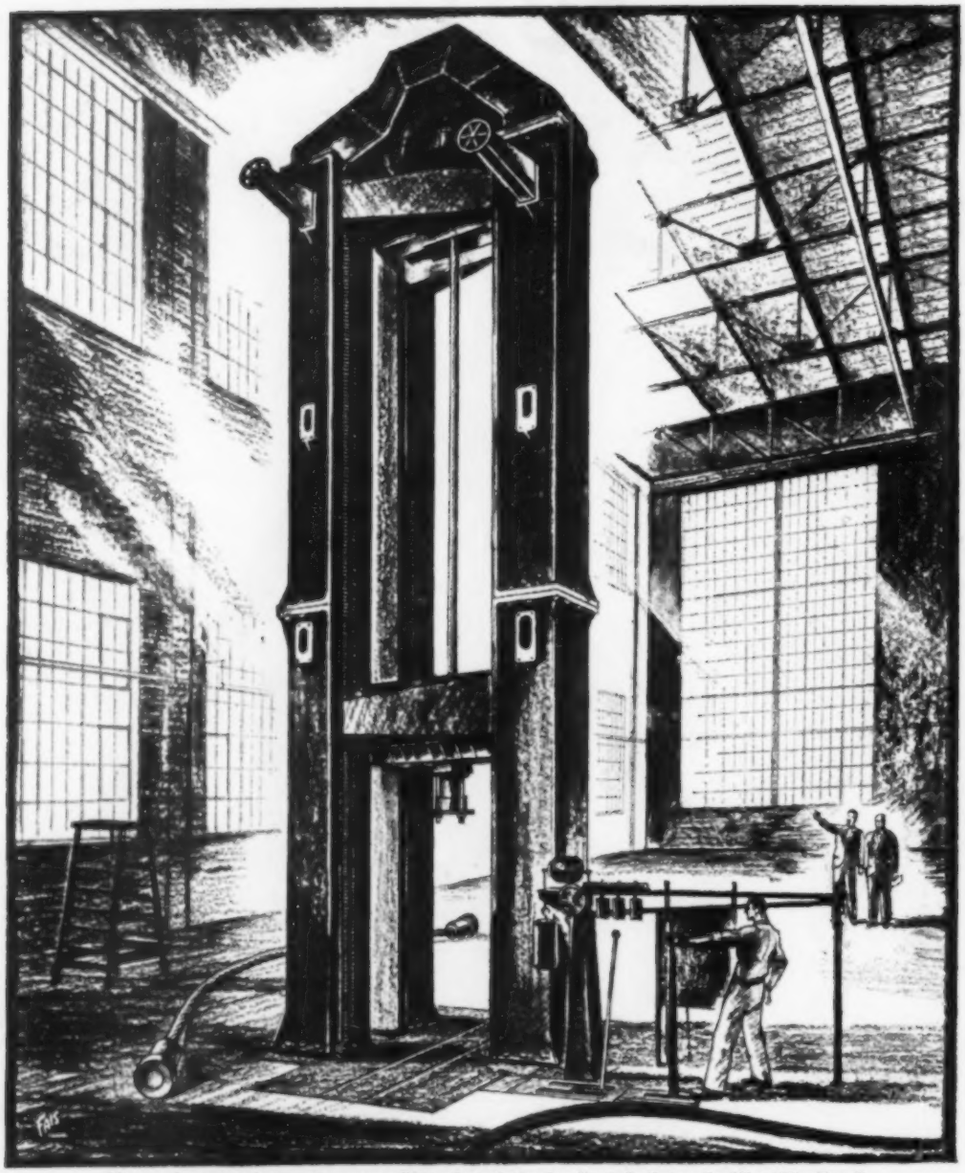
THE RESPONSIBILITIES OF LEADERSHIP

SERVICE is the only road to Leadership. Once arrived, there is no stopping-off place. The road leads on, even though the traveling becomes more difficult. Leadership seeks no rest, no selfish indulgence. It courts no glory, no celebration. Rather, it girds itself for the heavier responsibilities of leadership—to keep the faith of the industry—to meet the bigger expectations of those to be served—to pioneer the unknown—to overcome new obstacles with new methods—to continue on, maintaining a step ahead, in the glaring sun of publicity that beats on Leadership. Owen recognizes and accepts these responsibilities in renewed pledges of greater service to all Clamshell Bucket users.

THE OWEN BUCKET CO., CLEVELAND, OHIO

Owen Buckets

A MOUTHFUL AT EVERY BITE



No. 13 of a series of advertisements on "How Superlative Quality is Built into Roebling Wire Rope"

A *Tower of Torture* for Wire Rope

A 3¼ inch rope is "on the rack". A lever is thrown. The massive screw columns slowly turn. The rope draws taut . . . now you begin to see its mettle. 500,000 lbs. tension! 1,000,000 . . . the wires begin to snap! Finally . . . an ear-splitting report . . . and the broken strands lash back from the break.

So goes one of Roebling's regular routine specification tests on this giant Riehle, built originally to test the huge cables for the George Washington Bridge. It is one of the largest precision testing machines in the world, 2,500,000 lbs. in capacity, 43 feet high, 138 tons in weight. It tests by compression as well as tension . . . can crush a 15-foot cast iron column, 15" in diameter, with 1¼" walls! This formidable machine marks one extreme to which Roebling goes in testing wire and wire rope. At the other extreme are midget machines to test wire under a few ounces of tension. And in between are machines of every conceivable type and size. To make certain that in Roebling Wire Rope there will be a maximum of strength, stamina and safety, no stone has been left unturned.

JOHN A. ROEBLING'S SONS COMPANY, TRENTON, N.J.

Branches in Principal Cities *Export Dept.: New York*

WIRE · WELDING WIRE · FLAT WIRE · COPPER AND INSULATED WIRES AND CABLES · WIRE CLOTH AND WIRE NETTING

ROEBLING "BLUE CENTER" STEEL **WIRE ROPE**

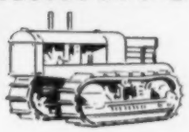
COMPANION TRACTORS

Allis-Chalmers Models "35" and "L"

The powerful, flexible Model "L" forging ahead through sand, loam or clay, casting *more dirt*, for the sturdy, fast "35"s to make *more trips*. In these A-C tractors are embodied the sound engineering principles that have made Allis-Chalmers justly famous. They are "GO-GETTERS", these companions. *Allis-Chalmers dealers are ready to show you.*

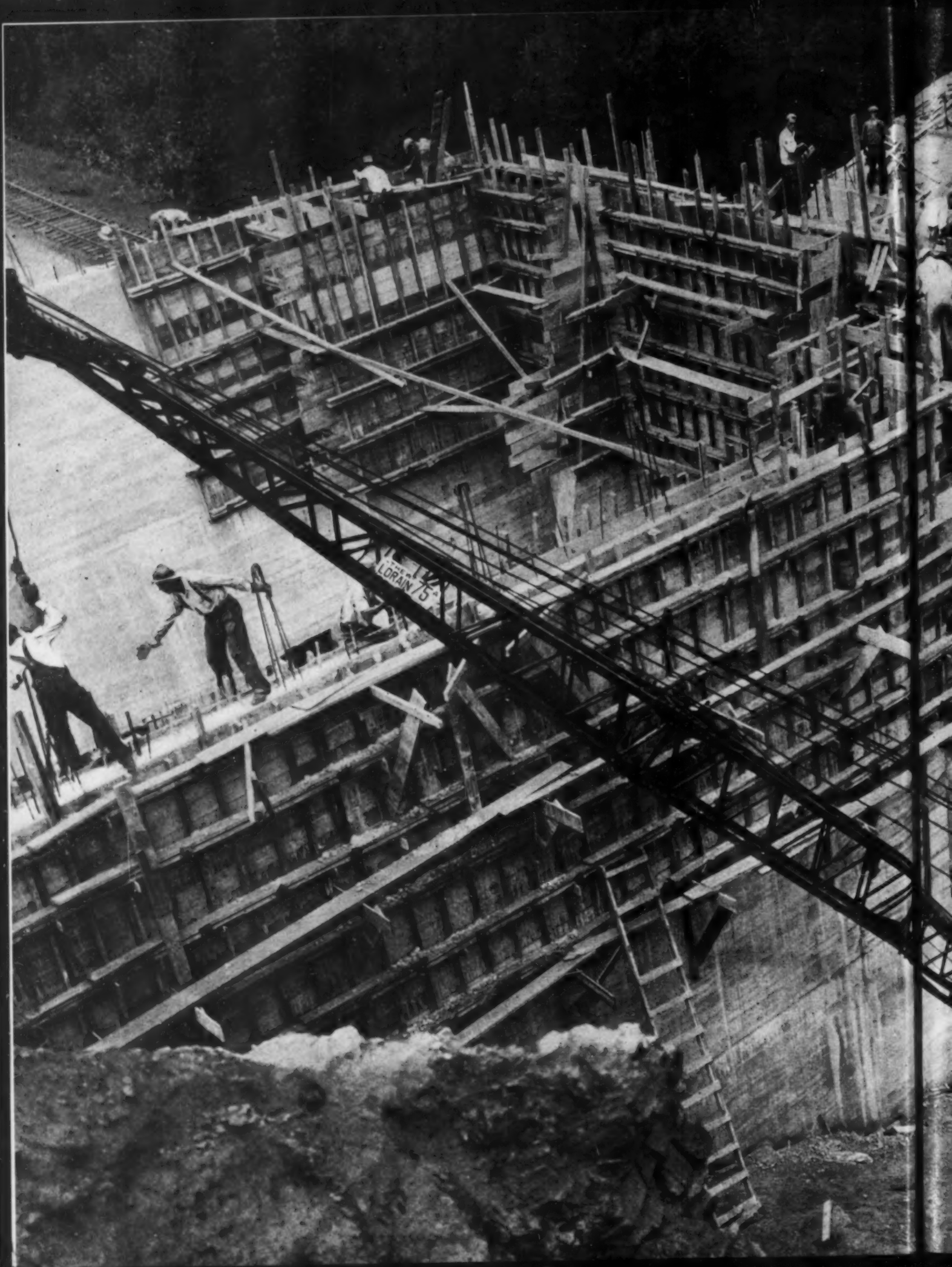
SPEED — POWER — ECONOMY — PERFORMANCE

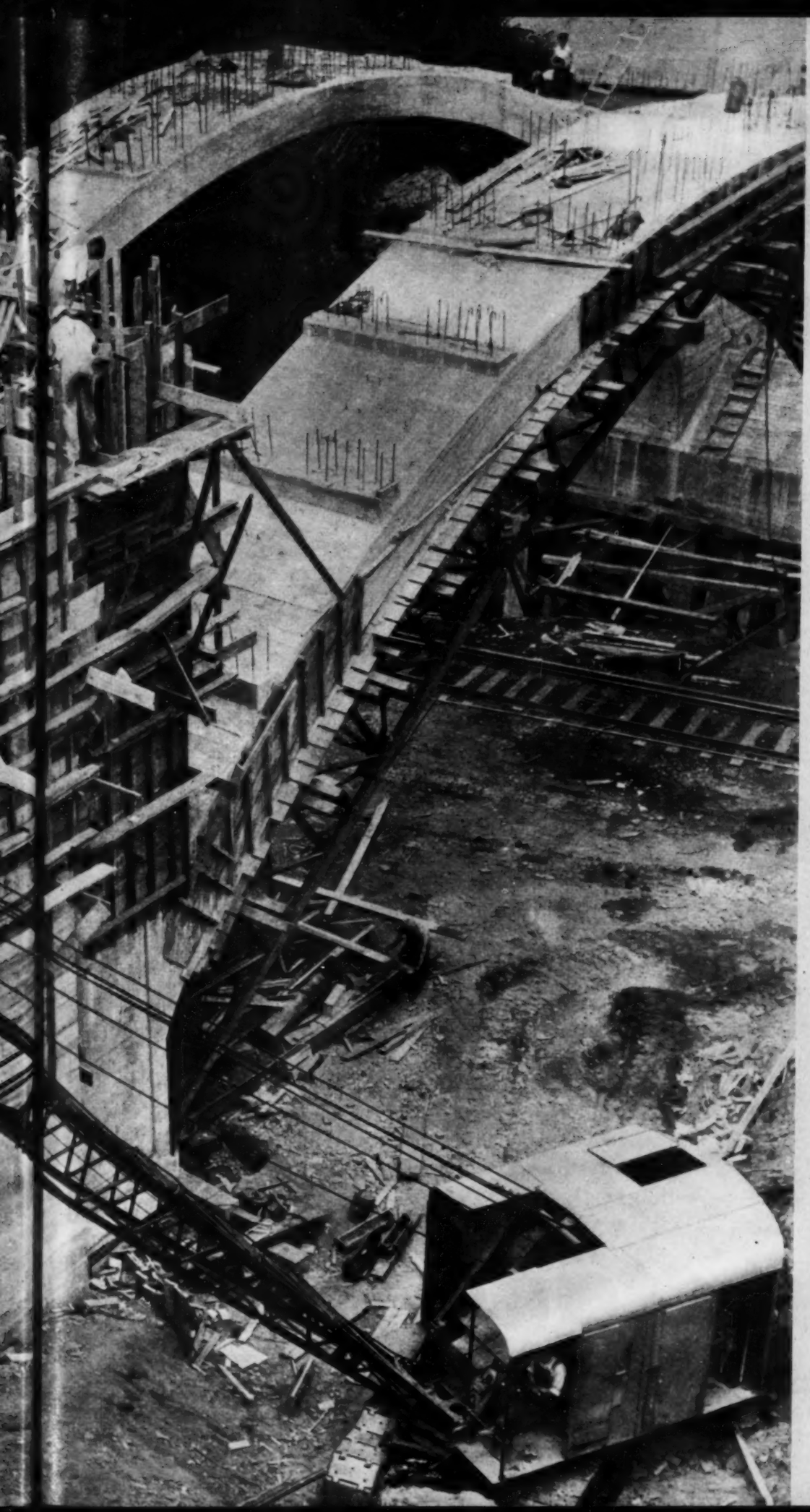
ALLIS-CHALMERS



MILWAUKEE, U. S. A.

"Allis-Chalmers Power for Every Purpose"


LORAIN 75



BACK-BONE

When it comes to tough assignments, Lorain machines get the job. There is never any doubt about Lorain backbone, whether it is a shovel to dig rock, a dragline to pull full buckets through, or a crane to handle an extra long boom. The Thew Shovel Company · Lorain, Ohio.

THEW LORAIN

Lorain 75 crane with 65 ft. boom helping put up the backbone of a new concrete bridge at Gwynn's Falls Creek, near Baltimore.

100,000 MILES!
and on the Original Air

Note the condition of the Firestone Tread. Still many miles of wear after 100,000 miles of hard service.

I feel you will be interested to know that I have one of 34X7 Firestone H.D. tires - have run approximately 100,000 miles and should run for at least 15,000 more judging from their present appearance. The tires on the trailer have the original air in them today.

LISTEN
to the ***Voice of Firestone*** *Every Monday Night Over N. B. C. Nationwide Network.*

LOOK at these tires. They've never been off the rims—still running on the original air. Their non-skid tread is not yet worn smooth . . . But actually they've gone 100,000 miles! And the owner, Fred L. Putnam, of Antwerp, Ohio, says they look good for 15,000 more.

Every day brings us new records of Firestone Tire mileage—records that mean real economy to countless truck owners. YOU can enjoy that same economy, too, by equipping your trucks with Firestone Gum-Dipped Tires, backed by Firestone Service. Talk with your nearby Firestone Dealer. He'll show you in a few minutes how Firestone Tires will save you actual cash—as well as costly delays.

Firestone GUM-DIPPED TIRES

BATTERIES « « RIMS « « BRAKE LINING « « SPARK PLUGS « « ACCESSORIES

Copyright, 1931, The Firestone Tire & Rubber Co.

BYERS GOLDEN ANNIVERSARY

A half century completed —1882-1932
Now a new 50 years begun —1932-1982

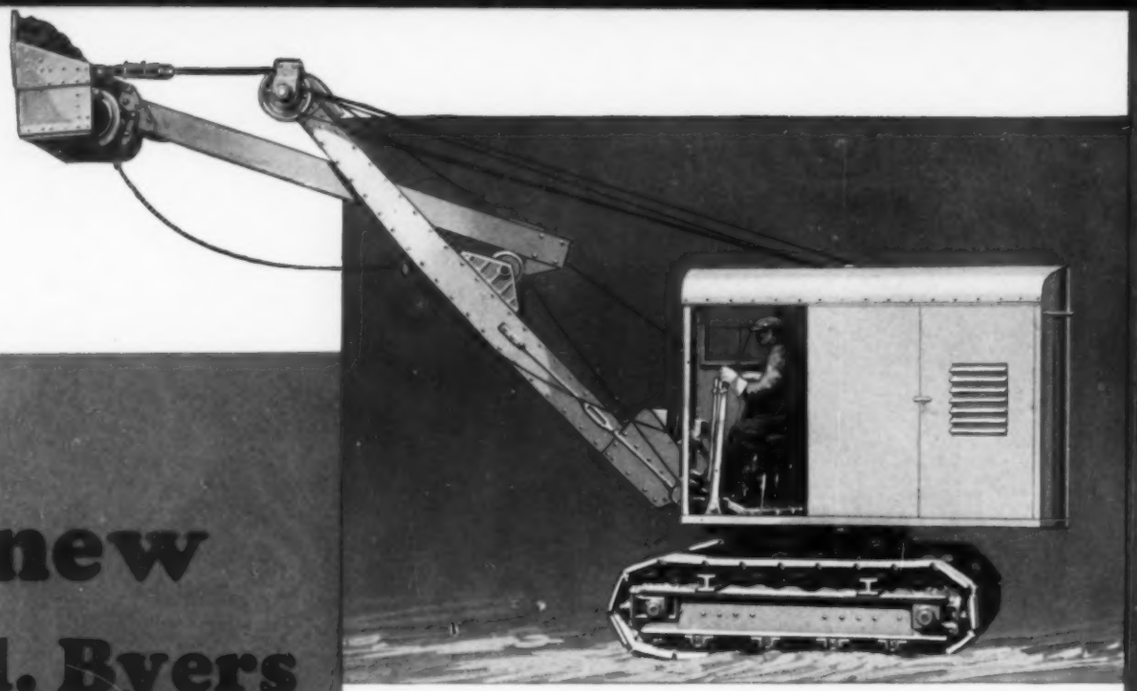
50 SUCCESSFUL YEARS OF BUILDING EXCAVATING MACHINERY
50 PROGRESSIVE YEARS OF CONSTANT DEVELOPMENT AND GROWTH
50 SERVICEABLE YEARS OF FAIR DEALING AND OF LIBERAL POLICIES

THAT is why The Byers Machine Company is in the front rank among shovel builders — why Byers' shovels and cranes are preferred by leading contractors and public officials — why you should investigate the outstanding value and proved performance in Byers' 1932 line of shovels and cranes before your next buy.

Decide now to learn about these new, rugged 1932 Byers' shovels and cranes. They're big—husky—with unit steel castings—powerful motors — all independent operations—they will do everything any other good shovel or crane will do, and a lot more. Now Byers' new 3/8 yd. full revolving rig completes the great Byers' line. See its picture on the next page. Then see it in action. Write for information.

The BYERS MACHINE *Co.*
RAVENNA, OHIO
Improved Sales and Service Throughout the Country

DETROIT PUBLIC LIBRARY



Here is the new 3/8 yd. Byers

WITH all the fine 1932 quality and features to meet a close-margin year like 1932 is going to be. With all the operating and design features of Byers' large heavy duty shovels and cranes.

The new 3/8 yd. is complete in every detail from independent cable crowd and Byers' patented cable shock absorbers to worm boom hoist and chocking from the cab. Complete and as well built as today's finest automobiles.

Byers ⅜ yd. crane can hoist, swing, travel and steer at the same time just the same as Byers larger cranes can.

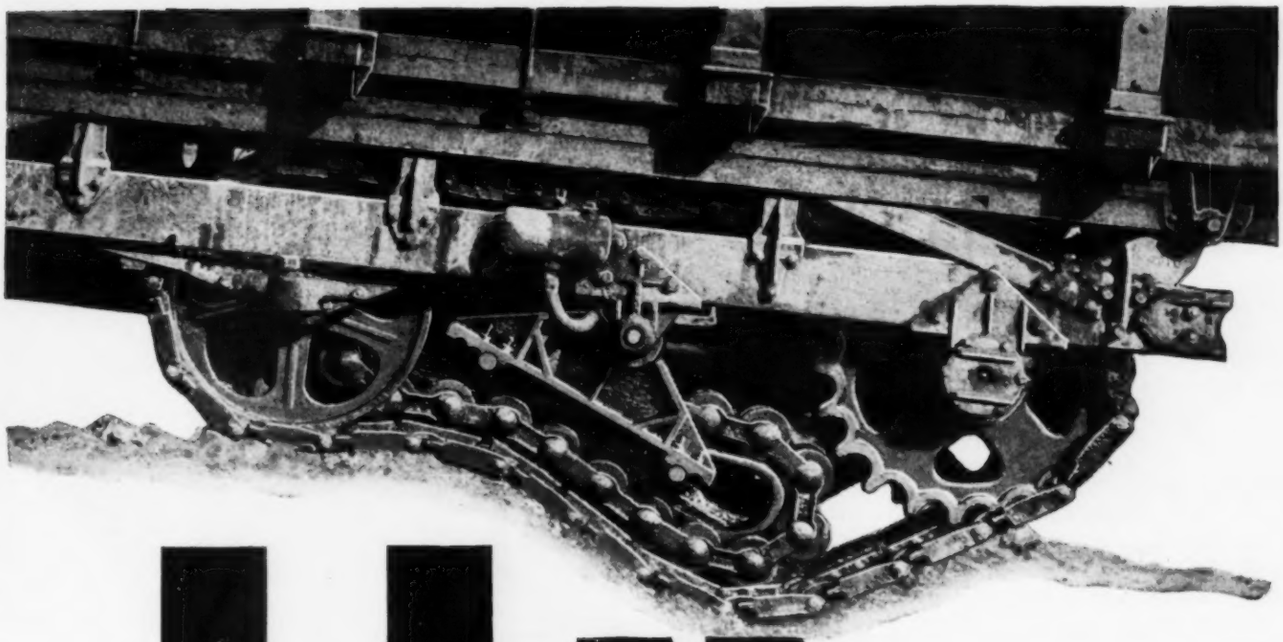
Decide now to get a look at this fast dependable 3/8 yd. It's not just another shovel—it's THE one shovel for you.

Its price will surprise you! Ask for it and for its specifications today. Get them by mail now!

The BYERS MACHINE CO., Ravenna, Ohio

Improved Sales and Service Throughout the Country

BYERS 3/8 • 1/2 3/4 • 1 • 1 1/4



LINN

..MAKES THE GRADE!

Carrying a pay load even under adverse ground conditions, LINN marches on where an ordinary truck or tractor lies down.

LINN TRACTORS

Patent No. 1,270,531
Patent No. 1,521,454
Patent No. 1,685,641
Patent No. 1,685,676
Patent No. 1,701,979
Patent No. 1,809,344
Other Patents Pending

Nielsen Certified Surveys on LINN performance in all classes of work will be sent upon request. These surveys give unbiased facts and figures which will enable you to estimate costs to the fractions.

more YDS. PER DAY

Whatever your hauling or construction job, LINN will make the toughest grade easy... and at a low cost.

LINN MANUFACTURING CORPORATION
(Division of La-FRANCE-REPUBLIC Corporation)
Factory, Morris, New York

Represented in:

New York City
Skowhegan, Maine
New Haven, Conn.
Johnson City, Tenn.
Pittsburgh
Louisville, Ky.
Chicago
St. Louis
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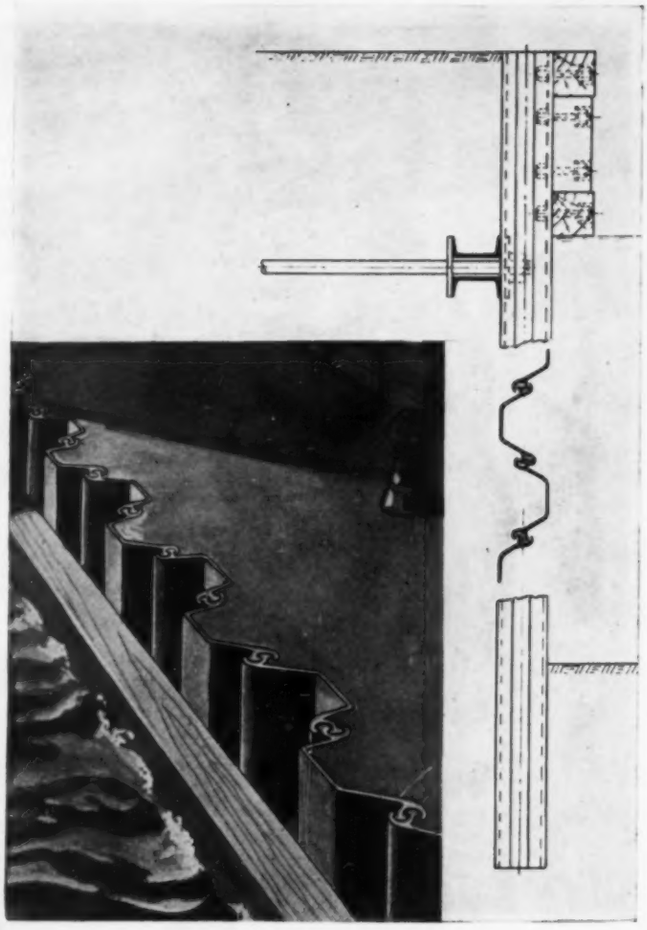
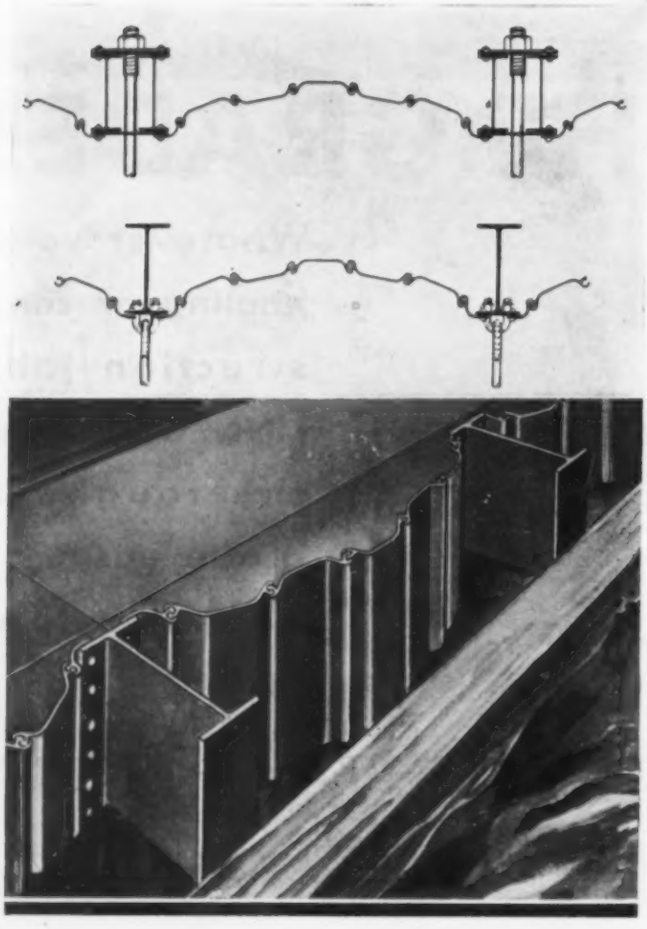
Kansas City, Mo.
Little Rock, Ark.
Sioux Falls, S. D.
St. Paul, Minn.
Salt Lake City
Denver
Los Angeles
Portland, Ore.
Spokane
Allentown, Pa.

Canadian Linn Distributors: Mussens Limited, Montreal

Modern Steel Wharves

Three efficient and economical types of modern wharf and bulkhead construction are illustrated herewith. On the right is shown the type for all depths of channel up to 25 feet. Carnegie Arch-Web Steel Sheet Piling has proved particularly efficient for this construction. A number of arch-web sections of varying weights and depths are available to meet the required strength for this range of depths. Section M110 is illustrated, with a driving width of 16", depth of 6" and a section modulus of 15.26 in.^{3} per foot of wall.





On the left are shown two types of construction for channels deeper than 25 feet. By varying the weight of the C B Sections and the spacing of the master piles, a wharf for any depth of channel and any surcharge load can be constructed. No waling is necessary in this construction.

Numerous installations have definitely proved the efficiency and economy of these three types. Carnegie Engineers are ready to consult with you at any time.

Carnegie Steel Company, Pittsburgh
Subsidiary of United States Steel Corporation 160

Carnegie Steel Sheet Piling

TOLEDO TORCHES

the harder it blows the better they burn

CHAMPION
$22.00 per doz.
F. O. B. TOLEDO, O.

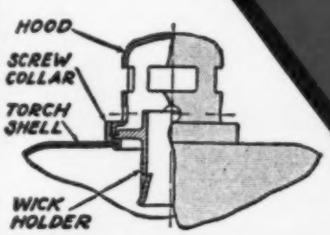
The CHAMPION. This is unquestionably the finest kerosene road construction torch on the market; heavily made of 14 gauge steel; welded throughout; self-righting; capacity 6 pints; burns up to 48 hours on one filling; prescribed for use in city congestion and on heavily travelled roads; shipping weight, 90 lbs. per dozen.

The LEADER. This is the most popular torch on the market; same specifications as above except that this torch is made of 20 gauge steel and the halves are joined together by a leak-proof, double-seamed joint; shipping weight, 78 lbs. per dozen.

Sig-nal-ite Model A. This torch is not self-righting but is otherwise similar to the LEADER; capacity 6½ pints; satisfactory for road use when placed beyond the lane of traffic and especially suitable for sign illumination on temporary detours; shipping weight 35 lbs. per dozen.

Sig-nal-ite Model F. This non-self-righting torch is made especially for use by truck and bus operators during emergency stops at night, as prescribed by certain states; reduced in height for convenient storage under the cab seat; capacity 4½ pints; shipping weight 33 lbs. per dozen, 6 lbs. per pair. This torch can be supplied with two rings instead of one, permitting carrying of the torch on hooks beneath the truck body instead of under the cab seat.

LEADER
$18.00 per doz.
F. O. B. TOLEDO, O.



The ECONOMY BURNER

This is a patented feature of great importance and is found in its perfected form, only on Toledo Torches. It automatically regulates fuel consumption to a maximum of efficiency and insures a dependable signal at all times. It can be attached to old style torches by means of the adapter shown below.

WICKS

Extra wicks are available in minimum packages of one dozen each; best quality for torch usage; all cotton construction, braided and of standard 18 inch length. Price $1.50 per dozen, postpaid.

NAMEPLATES

Die-cut steel nameplates to identify ownership may be welded to any of the above torches, at the factory, at an additional cost of $1.25 per dozen, small lots $.15 each.

All torches are finished in black, baked enamel, of high quality and durability. Standard package ¼ dozen.

Sig-nal-ite Model A
$12.00 per doz.
F. O. B. TOLEDO, O.

Hood

Wick-holder

Adapter

Hood: made of heavy gauge steel; chromium plated; fits all torches using Economy Burner; price $.15 each, postpaid.
Wick-holder; the indispensable wick-supporting member; held in place by the hood; retains proper wick adjustment at all times; price $.15 each, postpaid.
Adapter; used only to attach the Economy Burner to old style torches; price $.25 each, postpaid.
Complete Economy Burner: comprised of one each of parts shown above; for attachment to old style torches; price $.50 each, $5.00 per dozen, postpaid.

Sig-nal-ite Model F
$12.00 per doz. F. O. B. TOLEDO, O.

THE TOLEDO TORCH
RIGHTS ITSELF FROM ANY POSITION

The Toledo Pressed Steel Co.

TOLEDO OHIO

Save with Steel

Views of the new Mt. Vernon Memorial Boulevard connecting the nation's Capital with the home of Washington. Contractors: Roberts Paving Company, Salisbury, Md., and McDougald Construction Company, Atlanta, Ga. Carey Elastite Expansion Joint used throughout—supplied by Asbestos Covering & Roofing Co., Washington, D.C.

Carey Elastite
REG. U.S. PAT. OFF.
TRADE MARK REG'D U.S. PATENT OFFICE
Expansion Joint

"Makes Good Paving Better"

For over 20 years Carey Elastite Expansion Joint has been protecting concrete highways against expansion and contraction stresses. Engineers specify it to insure definite results—road builders know that it is stocked in all principal centers, insuring prompt delivery.

1932 price list and trade discounts will be sent on request.

THE PHILIP CAREY COMPANY • *Lockland*, Cincinnati, Ohio
BRANCHES IN PRINCIPAL CITIES

BUILT-UP ROOFS
ASPHALT PRODUCTS
ELASTITE EXPANSION JOINT
WATERPROOFINGS
ROOF PAINTS

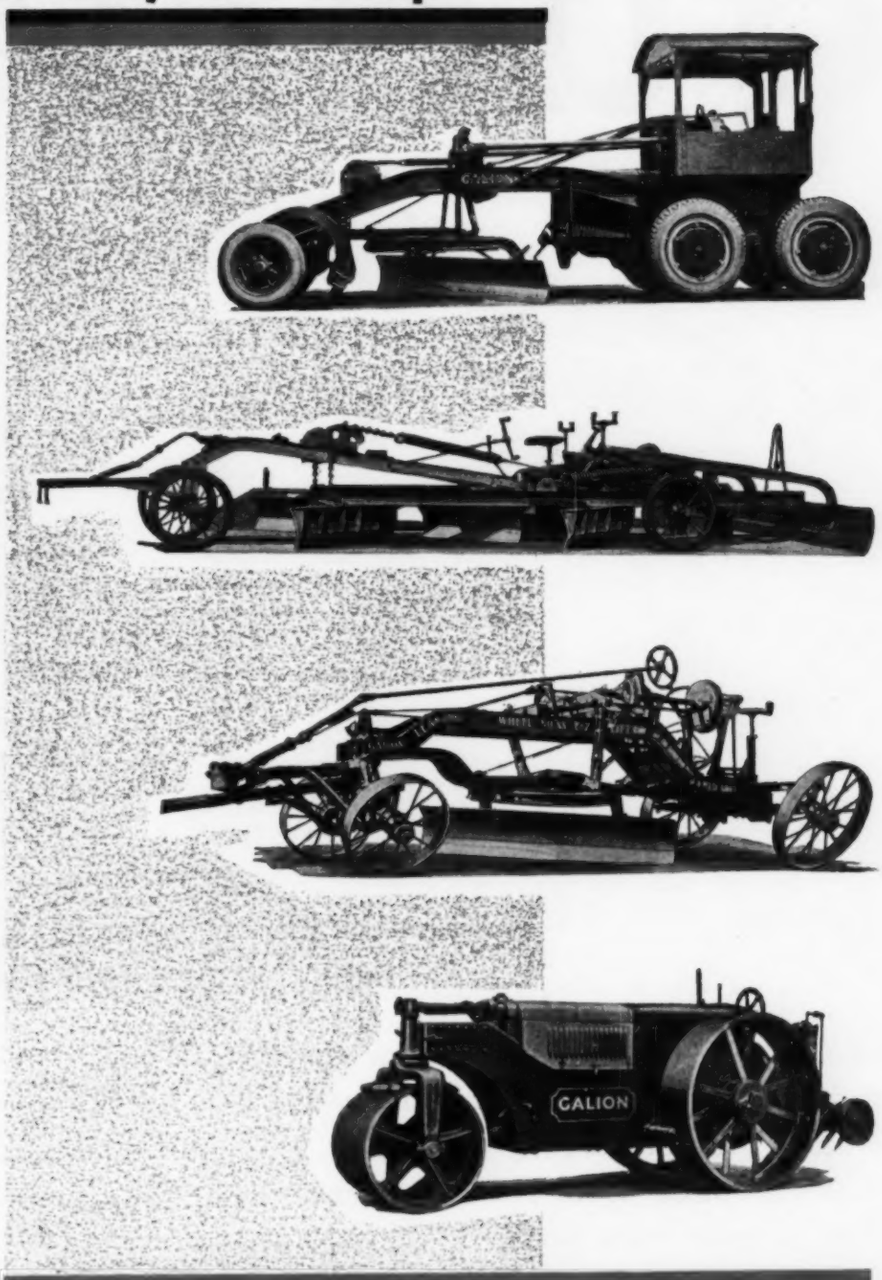
Carey PRODUCTS

HEAT INSULATIONS
ASBESTOS MATERIALS
CAREYSTONE CORRUGATED SIDING
ASFALTSLATE SHINGLES
BUILDING PAPERS

606

The GALION

Line of Road Working Machinery is Complete



Galion E-Z Lift Motor Patrol Graders with Double Drive, providing four-wheel traction with full flexibility.

Galion Mixing and Leveling Drag--especially designed for mulch or retread work. Accomplishes a thorough mixing of material and levels it ready for rolling.

Galion E-Z Lift Leaning Wheel Graders--made in various sizes and weights with moldboards ranging in length from 7 to 14 feet.

Galion Master 4-cylinder Motor Roller-- ruggedly constructed and well braced. Has abundant power. 10 and 12-ton sizes.

Full details on request.

FOR SUCCESSFUL PERFORMANCE A.G.C.M.A.

DISTRIBUTORS EVERYWHERE

The Galion Iron Works & Mfg. Co.

GALION . . . . . OHIO

NARROW quarters

CLEARING the deck of a scow forty-two feet wide—that's proof of the nimbleness of a "Caterpillar" Tractor. Doing the job in 3½ hours—that's proof of "Caterpillar" power and stamina. The Lincoln Park Board of Chicago uses one of its "Caterpillars" in this novel way to move sand from the wrong place to the right place. Large cities and small ones find "Caterpillar" Tractors endlessly useful.

Prices—f. o. b. Peoria, Illinois

TEN	$1100	THIRTY . . .	$2375
FIFTEEN. . .	$1450	FIFTY . . .	$3675
TWENTY. . .	$1900	SIXTY . . .	$4175

Caterpillar Tractor Co., Peoria, Illinois, U.S.A.
Track-type Tractors Combines Road Machinery
(There's a "Caterpillar" Dealer Near You)

CATERPILLAR

REG. U. S. PAT. OFF.

TRACTOR

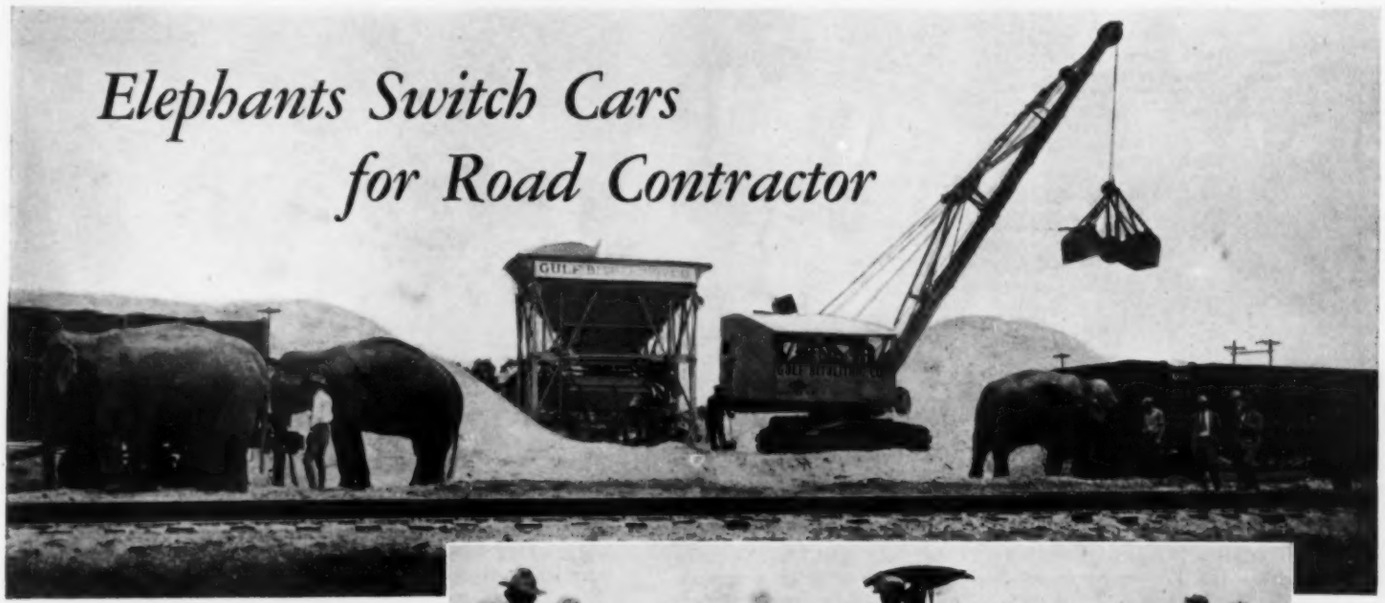
Construction Methods

ESTABLISHED 1919—McGRAW-HILL PUBLISHING COMPANY, INC.

ROBERT K. TOMLIN. *Editor*

VOLUME 14 NEW YORK, JANUARY, 1932 NUMBER 1

Elephants Switch Cars for Road Contractor



CIRCUS PACHYDERMS are drafted into temporary service to move cars of sand and stone at contractor's material yard.

BITUMINOUS MIX, delivered by motor trucks from contractor's plant in Houston, is dumped on concrete base and spread to smooth surface by finishing machine before final compaction by rolling.

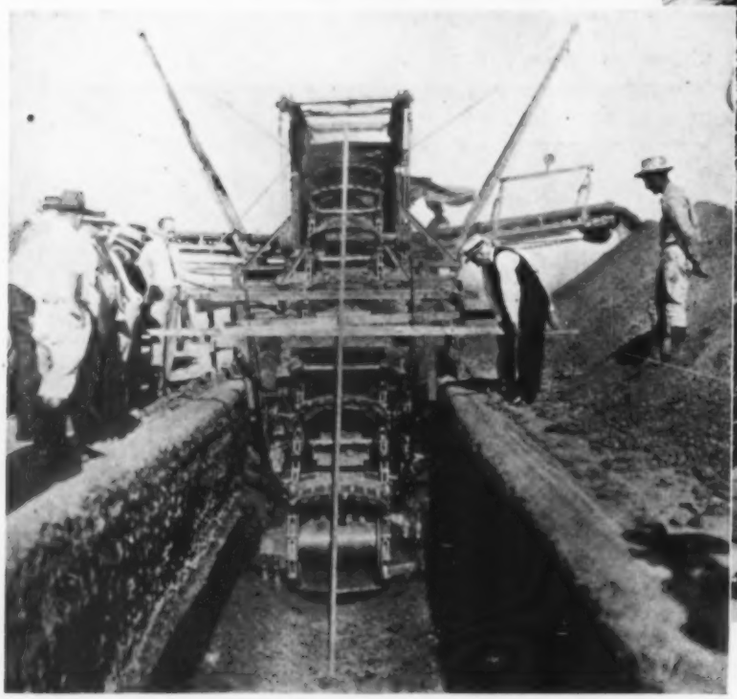
WHEN railway switching facilities were inadequate to move cars of sand and stone needed in a hurry for the construction of a new 12½-mi. black-top highway on concrete base between Houston and LaPorte, Tex., the Gulf Bitulithic Co., of Houston, sent out the old circus man's call of distress, "Bring up the elephants," always heard when wagons sank hub-deep in muddy country roads. The answer came quickly. A herd of pachyderms happened, at the time, to be enjoying a lay-off from regular duty with Christy Brothers' circus at Houston and were at once drafted into road-building service at the contractor's material-handling yard and batching plant. Scenes typical of India were re-enacted along the shore of the Gulf as the huge beasts, guided by mahouts straddling their ponderous necks, shunted gondola cars of sand and stone about the contractor's yard and spotted them for unloading by a clamshell bucket on a crawler crane.

The new highway connecting Houston with a popular seaside resort on Trinity Bay, constructed by Harris County under the direction of Charles R. Haile, county engineer, and named in honor of Rollin Herbert Spencer, former commissioner of the district in which it is built, consists of a 20-ft. width of Warrenite-Bitulithic non-skid surface on a 6-in. reinforced concrete base, with 5-ft. shell shoulders on flat slopes at each side. The surface is of two-course construction, having a thickness of 1½ in. Produced at the contractor's central plant, the hot bituminous mix was carried to the job by motor trucks, dumped on the concrete base and spread by a Lakewood finishing machine, as illustrated in the picture above. After the binder course had been spread by the finishing machine, it was lightly compacted by a 5-ton roller. A top course of granular material was then placed upon the binder course, spread mechanically, and compressed by a 10-ton three-wheel road roller.

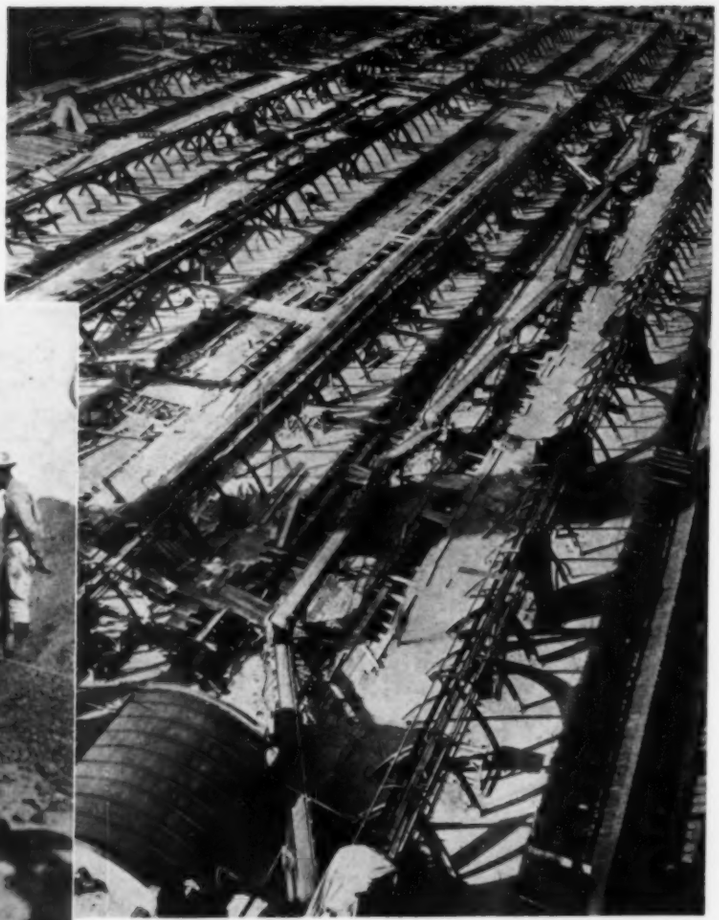
The 6-in. concrete slab constituting the base of the pavement is heavily reinforced with a mat of steel bars and is divided along the center line by a longitudinal joint.

A feature of the design of the highway is the widening at bridge approaches to eliminate the "bottlenecks" often found at these points.

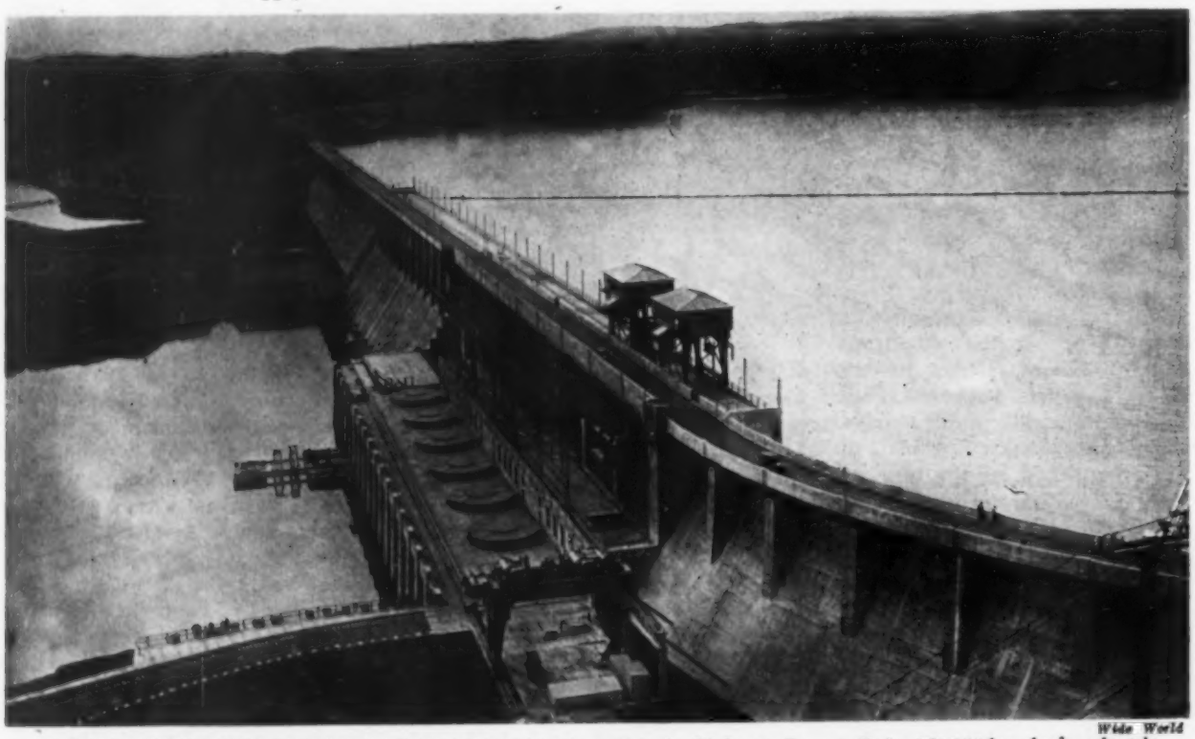
This Month's "News Reel"



TRENCHING FOR HETCH HETCHY AQUEDUCT. Youdall Construction Co. starts 50-ton Buckeye excavator on last section of ditch to receive 62-in. steel pipe line for San Francisco's water supply.

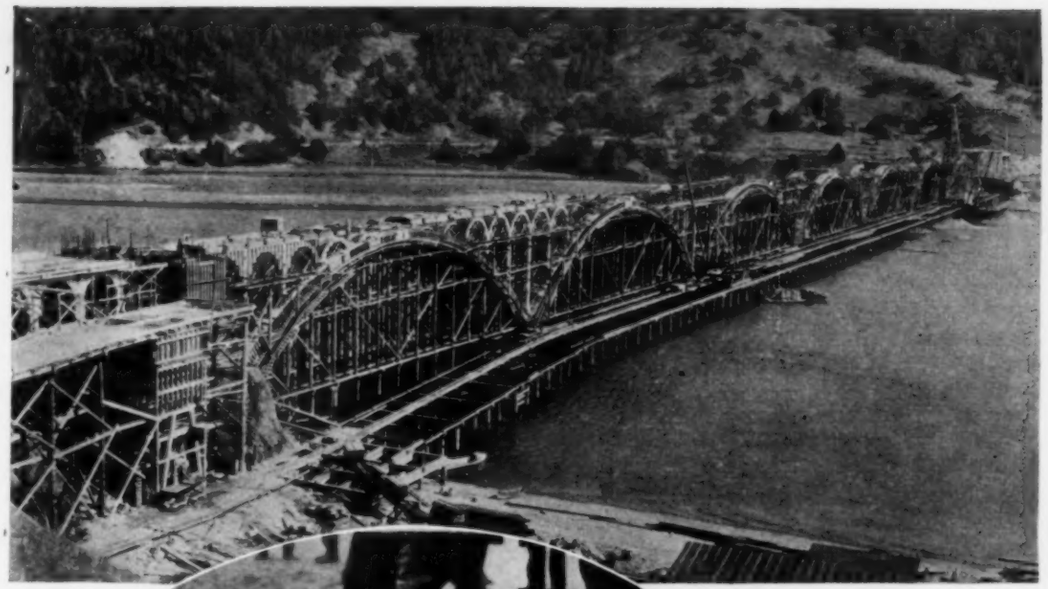


BELT CONVEYORS are employed extensively by John Griffiths & Son Co., contractor, to handle both excavated earth and wet concrete for Chicago's new postoffice building. This view shows 18 Barber-Greene portable units, in tandem, conveying concrete for nine-story structure, 800x344 ft. in plan, located over railroad tracks.



Wide World

WATER RISES BEHIND OSAGE RIVER DAM of Union Electric Light & Power Co.'s 268,000-hp. hydro-electric project at Bagnell, Mo. Concrete for half-mile long structure, built by Stone & Webster Engineering Corp., to height of 148 ft. above bedrock, was distributed by cars and gantry travelers from steel construction bridge 1,932 ft. in length, as described in *Construction Methods* for May, 1931, p. 38.

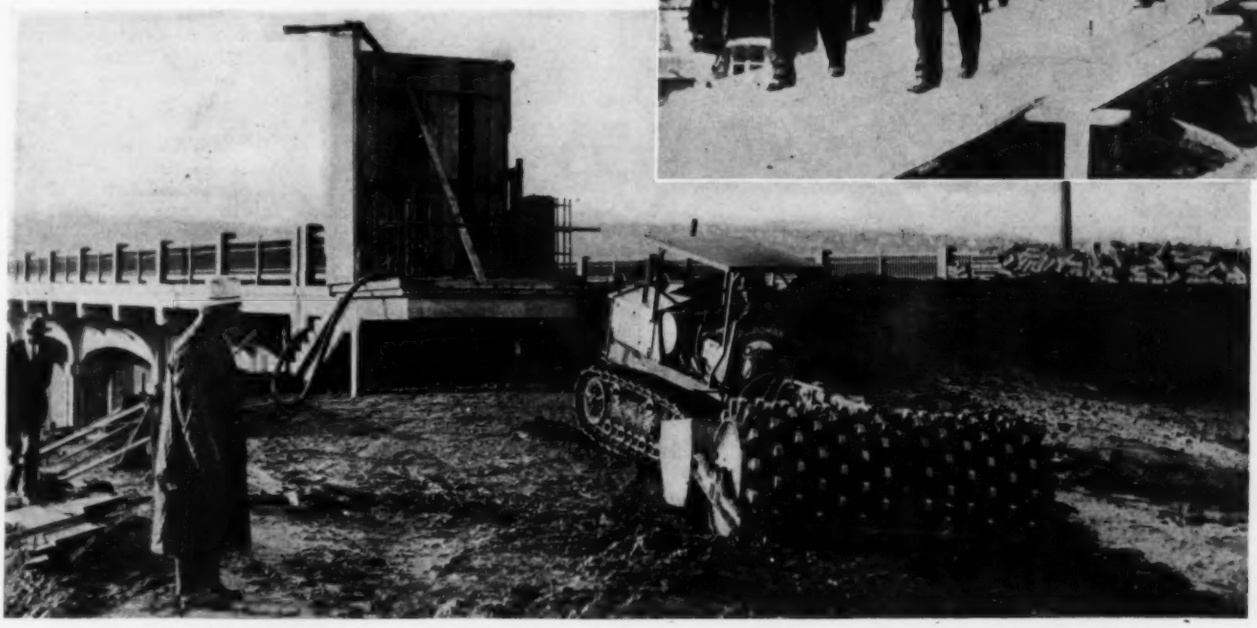


CENTERING *(left)* is erected by Mercer-Fraser Co., contractor, of Eureka, Calif., for seven 230-ft. concrete arch spans of Rogue River bridge, designed by C. B. McCullough, bridge engineer of the Oregon State Highway Commission. Completed arches will be jacked off centering and adjusted in accordance with Freyssinet method of construction.

MUSSOLINI *(below)*, Italian premier, makes official inspection of building operations in progress at new Forum in Rome, named in his honor.

Wide World

PAVED WITH IRON. Demonstration road near Works, Roads and Transport Congress and Exhibition in London is surfaced with new type of triangular metal block, bedded in bituminous cushion on concrete base.



COMPACTING EARTH FILL for approach to new Aurora Ave. bridge over Lake Union, Seattle, Wash. R. J. Odman, contractor, tamps 40,000 cu.yd. of earth embankment with Ateco sheeps-foot roller hauled by a Cleveland tractor.

In Concreting Boston-Worcester
TRUCK-MIXERS REPLACE

ON THEIR contract for building, west of Framingham, Mass., 5 miles of the new concrete super-highway extending in an almost straight west-east line between Worcester and Boston, Mass., B. Perini & Sons, Inc., of Ashland, Mass., made a radical departure from concrete paving practice common in New England by abandoning the use of the standard concrete paving mixer as the key unit in their plant set-up and substituting for it a fleet of fourteen 3½-yd. truck-mixers owned by the contractors and operated by them from a central batching plant.

To meet objections on the part of the state highway department's engineers to the possibility of segregation of the mixed batches of concrete if distributed from the trucks by inclined chutes the contractors devised a special portable belt-conveying rig to receive the truck-mixer discharge and carry it laterally to place on the subgrade.

With the methods and equipment in use on the broad boulevard, comprising four 10-ft. paved traffic lanes divided into pairs by a turf separating strip, progress averaged about 2,000 lin.ft. of 8-in. reinforced slab 10 ft. wide per 10-hour day. For each 10-ft. traffic lane the amount of concrete required was ¼ cu.yd. per running foot of pavement, so that a day's pour averaged about 500 cu.yd.

BATCHING PLANT *(above)*, with overhead bins and weighing hoppers, has through driveway, permitting rapid charging of 3½-yd. drums of truck-mixers.

SUPERHIGHWAY *(left)* has two 20-ft. concrete-paved traffic lanes separated by sodded center strip. Concrete bridges carry north-south local roads over new Boston-Worcester turnpike.

Design of Super-Highway—The new Boston-Worcester turnpike provides a through-traffic route about 45 miles long, reducing by one-half hour the former running time by automobile between the two cities. The design is noteworthy in several of its features. Traffic proceeding in opposite directions on the two 20-ft. paved strips of the super-highway is separated by a central strip 8 to 10 ft. wide, faced with granite curbing and planted with grass. This feature minimizes the motor accident hazard, in addition to adding materially to the beauty of the highway. At many of the intersections of the Boston-Worcester turnpike with existing north-south roads, grade crossings, with their attendant delays to traffic, are eliminated by the construction of concrete bridges to carry the transverse routes over or under the super-highway, leaving the latter clear for the continuous passage of fast-moving through traffic.

The roadway is paved with concrete, 8 in. thick, reinforced and poured in lanes 10 ft. wide. Transverse expansion joints are spaced at intervals of not more than 60 ft. For drainage purposes the concrete pavement is laid at a slope of ¼ in. per foot toward the gutters at each side and is supported by a base course of gravel 1 ft. thick.

Super-Highway PAVERS

SEPARATING STRIP prevents accidents by dividing traffic proceeding in opposite directions.

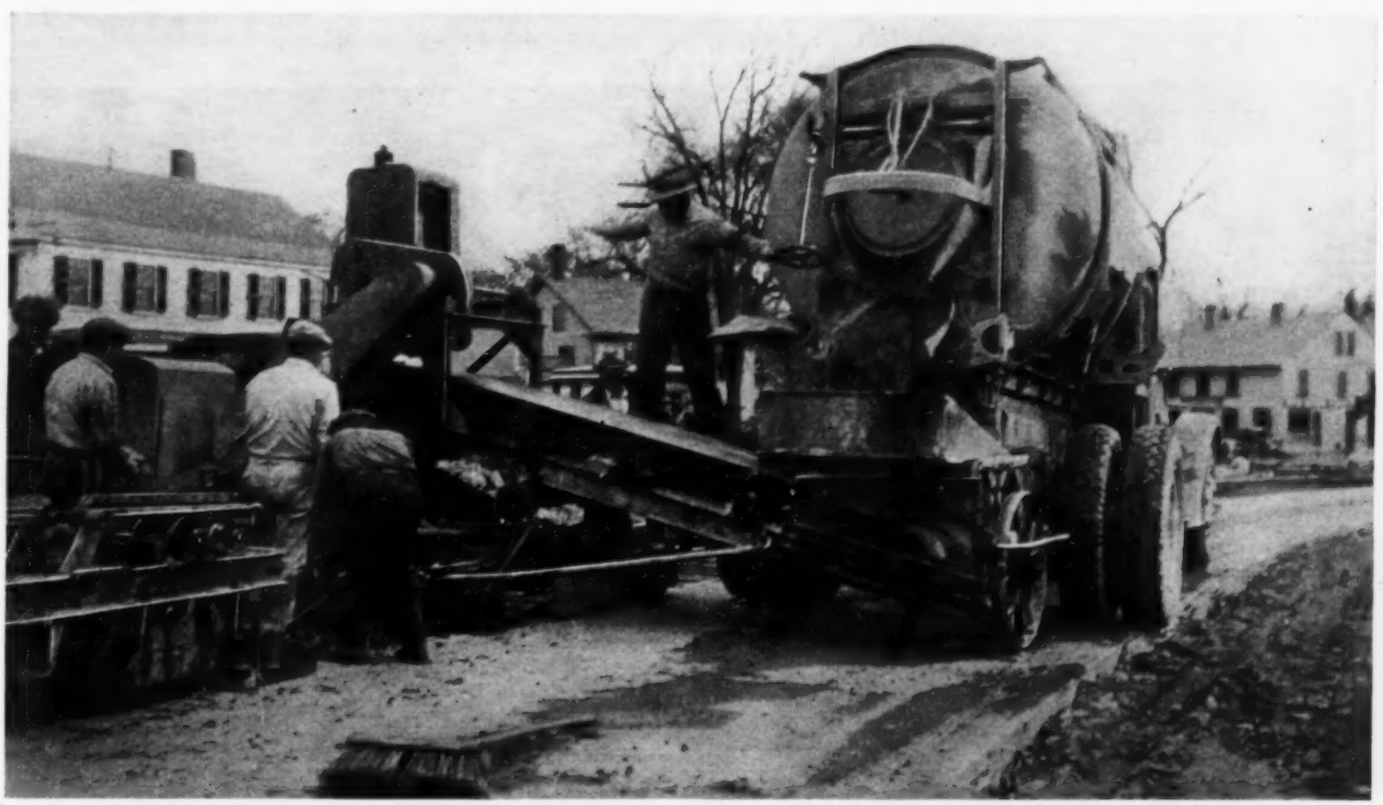
Special treatment is specified for the shoulders beyond the concrete pavement. Adjoining the outer edge of the slab is a 3-ft. strip of macadam 4 in. thick and, beyond that, a 7-ft. width of oiled gravel upon which a car may pull out for repairs or changing tires without blocking the paved roadway.

Revised Details—When the first sections of this type of super-highway were built the concrete paving of the two inner 10-ft. lanes was carried up flush against the granite curbing along the 10-ft. grass separating strip. Observation of motorists using completed portions of the boulevard, as thus built, indicated the desirability of a slightly increased width for the two inner, or passing, lanes to prevent cars from being crowded against the curbing of the separating strip. The design, therefore, was altered by reducing the width of the separating strip from 10 to 8 ft. and using the extra 1 ft. on each side for a band of cold-mix bituminous surfacing which serves the dual purpose of widening the inner lanes to 11 ft. and providing a sharply defined black band parallel to the inner curb line for the guidance of traffic.

JOHN DOHERTY *(left)*, contractors' superintendent, and W. F. DONOVAN, resident engineer for state highway department.

Experience with traffic using the super-highway suggests a further improvement in design detail by substituting for the vertical granite curbs along the central separating strip a sloping paved surface.

Truck-Mixer Method—In reaching the decision to mix concrete in transit on trucks, instead of in a paver operating on the subgrade, the contractors took into consideration these factors: The job was a fairly large one—$750,000, based on the bid prices,—and involved 25,000 cu.yd. of concrete pavement. It was a continuation of another section of the Boston-Worcester turnpike, further west, for which a $467,000 contract had previ-

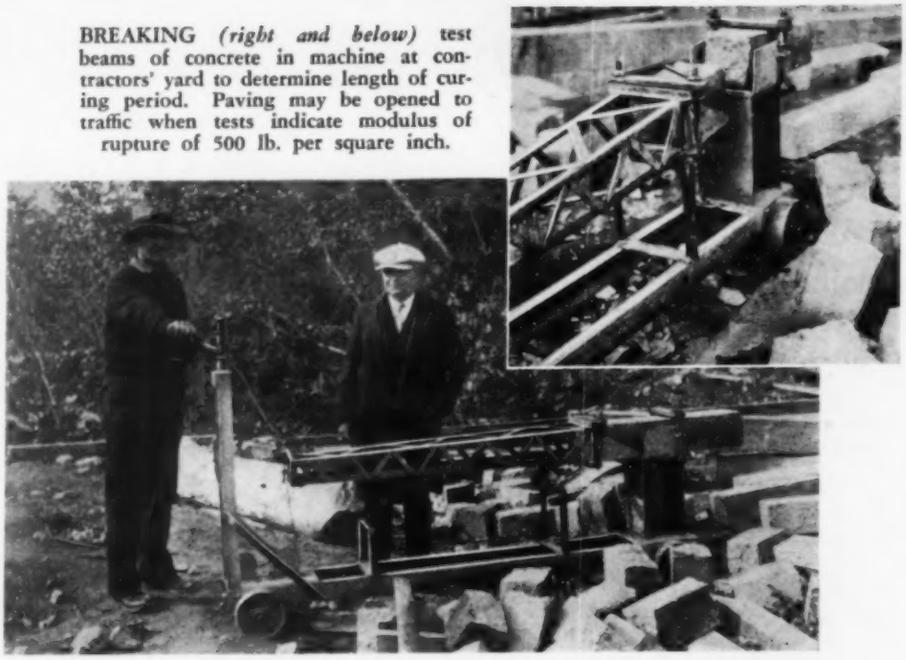


PORTABLE BELT CONVEYOR receives discharge from truck-mixer and carries it laterally about 10 ft. to subgrade. With this equipment a 3½-yd. batch is placed in from 1 to 1¼ min. Finishing machine (at left) follows closely behind belt conveyor.

ously been awarded to the same contractors and on which truck-mixers had been operated. Traffic could be detoured around the new construction on existing roads and a plentiful supply of sand and gravel for concrete was obtainable from a pit alongside the job, just west of Framingham, obviating the necessity of shipping aggregates by rail.

The chief reason for using the truck-mixers was to increase the daily production of concrete pavement. With a standard 1-yd. paving mixer and a minimum mixing time of 1¼ min. required by the Massachusetts specifications, the maximum production possible would have been somewhat less than forty 1-yd. batches per hour. With a fleet of truck-mixers, on the other hand, no such limit on concrete production obtains. Mixing is done in the truck-mounted drums en route from the batching plant, the trip taking at least 5 min.—generally longer. With a truck-mixer fleet, therefore, mixing time is not the same controlling factor in concrete production as it is in the case of a standard paver. Mixed batches from the truck drums can be placed on the subgrade just as quickly as the spreading and finishing crew can take care of them. Then, too, the volume of each batch from the truck-mixers is 3½ yd. as compared with 1-yd. from the standard 27-E paver.

One other important consideration deserves mention. In the case of a breakdown of a standard paving mixer concrete production stops while repairs are being made. With an adequate fleet of truck-mixers, however, there is greater flexibility and no shutdown need occur, for even if one unit is temporarily out of service there are enough others in the fleet to carry on with the concreting.



BREAKING *(right and below)* **test beams of concrete in machine at contractors' yard to determine length of curing period. Paving may be opened to traffic when tests indicate modulus of rupture of 500 lb. per square inch.**

It must be realized, of course, that concrete paving with a fleet of truck-mixers involves a substantially higher first cost for plant than does the standard paver method and is economical only when the size of the job and the increased production of completed pavement are large enough to absorb this item of added equipment expense. The outstanding advantage claimed for the truck-mixer method of producing concrete for paving is that it removes the bottleneck in the train of operations created by the time cycle of the standard paver working on the subgrade.

Fleet of 14 Truck-Mixers—In the present instance the Perini truck-mixer fleet on the Boston-Worcester turnpike contract consisted of 14 machines, each with a drum capacity of 3½ cu.yd. The mixer elements, 7 Jaeger and 7 Rex machines, were all mounted on Sterling motor truck chassis, equipped with pneumatic tires, including duals on the rear wheels.

TRUCK-MIXER *(left)* **receives charge of cement through flexible canvas boot from loading hoppers above.**

CEMENT HOPPERS *(above)* **discharge 23 bags per batch into truck-mixers below them.**

Central Batching Plant—At a point about 1½ miles from the east (Framingham) end of the 5-mile contract section, the contractor set up his central batching plant alongside a sand and gravel pit adjacent to the new superhighway. Loaded by power shovel into motor trucks the aggregates were dumped upon a grizzly, which diverted the oversize stones to a rock crusher

and allowed the remainder of the material, after the sand and gravel had been separated by washing and screening, to be delivered by an inclined belt conveyor to overhead bins equipped with Johnson hopper scales.

The water allotment for a batch varied from 520 to 600 lb., depending on the moisture content of the gravel which was determined frequently by weighing a batch dumped into a truck and, after elevating the body and allowing the water to drain off, again weighing the batch, noting loss of weight and correcting the water allotment.

The elevated sand hopper at the batching plant was first half-filled with water and then the sand was added, causing excess water to run off through overflow compartments. This procedure inundated the sand and carried off through the overflow any silt in the fine aggregate. This method of fixing the water content by weight was considered an improvement over the old system of providing water from the tanks on the truck-mixers. The water tanks on the trucks were used only to wash out the mixer drums. Wash water was introduced on the return trip and discharged when the truck arrived at the batching plant.

In addition to the water content,

CARRIAGE OF BELT CONVEYOR DISTRIBUTOR, as seen from front end, spans subgrade and is mounted on flanged wheels propelled by chain drive, as illustrated in picture at top of page.

DISTRIBUTING CONCRETE from truck-mixer by lateral belt conveyor. Each 3½-yd. batch is delivered in several piles by moving truck and conveyor ahead a few feet at a time.

HOPPER above lower end of belt conveyor receives concrete discharged from truck-mixer. Note spoked wheel on which rig travels in quarter circle when swung around parallel to road to allow truck to pass.

IN IDLE POSITION. Pivoted mounting allows belt conveyor to be revolved 90 deg. to provide clear passageway for trucks on completed slab.

which varied as outlined above, each 3½-yd. batch contained 3,634 lb. of sand, 8,070 lb. of gravel, and, for ordinary paving, 23 bags of Edison portland cement. On special work at important street intersections, where it was necessary to open crossings to traffic without delay, Incor high-early-strength cement was substituted.

After a truck-mixer had driven under the aggregate bins and received its charge it proceeded a short distance to an elevated cement-charging platform, equipped with two hoppers into each of which 23 bags of cement were emptied. With two hoppers it was possible to fill one while the other was being emptied into the truck-mixer below, thus avoiding delays in loading time. To prevent loss of cement the discharge opening of each loading hopper was provided with a flexible canvas boot which extended into the charging openings of the truck-mixer drums. The cement charging platform was built upon a side hill with a steep earth ramp leading up to it for the use of trucks delivering the cement.

The batching plant yard was laid out with through driveways under the aggregate bins and the cement platform, making it unnecessary for the trucks to do any backing or other time-consuming maneuvering. As soon as a truck received its charge of cement the operator started the drum rotating and mixing continued during the entire trip of the truck to the point where its load was discharged upon the subgrade. As a general rule each batch in transit to the job was mixed for a period of at least 5 min. The only restriction imposed by the state highway department on the transit-mixing method was that the concrete had to be delivered to place within one hour of the time the mixing drum was charged.

Portable Belt Conveyor—On reaching the scene of paving activities the truck-mixer discharged its 3½-yd. batch through an opening in the rear end of the drum upon a specially designed Barber-Greene belt conveyor, which carried the concrete laterally a distance of 10 ft. and deposited it upon the subgrade. The conveyor was mounted upon a carriage equipped with four flanged wheels riding, after the manner of a finishing machine, on the steel forms or, after a strip had been concreted, with one pair of wheels on the edge of the finished slab and the other pair on the forms. The machine was powered by two gasoline engines, one a Novo unit which drove the belt and the other a Le Roi, which propelled the carriage. In order that it might be swung around through a quarter circle to provide a clear passageway for the truck-mixers running along a strip of completed pavement, the belt conveyor was carried on a boom pivoted at its center and equipped at the charging end with a large flat-tired wheel, as illustrated.

GRANITE CURBING is placed by means of revolving crane mounted on motor truck.

FOR CURING CONCRETE and sprinkling subgrade, contractor rigged tank on truck. Long discharge pipe is connected to tank by swivel joint and may be rotated through half-circle to discharge on either side.

After a loaded truck-mixer had driven past and stopped, ready to discharge concrete, the belt conveyor was swung around through an angle of 90 deg. and maneuvered by its propelling mechanism until its receiving hopper was spotted directly underneath the discharge opening of the mixer drum. On the rear end of the truck an operator manipulated a hand-wheel controlling the rate of discharge from the drum. The mixed concrete, descending in a stream upon the moving belt, was carried laterally to the end of the belt and fell upon the prepared subgrade. A vertical baffle plate at the discharge end of the belt prevented the moving stream of concrete from being thrown too far out beyond the center line of the strip. As the concrete dropped from the belt it was spread evenly across the 10-ft. width of the subgrade between the forms by hand

shoveling. The entire 3½ cu.yd. of concrete in each batch was not deposited at a single point on the subgrade. Instead, the truck-mixer and the belt distributor were moved forward a few feet, from time to time, so as to distribute the concrete in several piles and facilitate the job of spreading, prior to the passage of the finishing machine.

As soon as a batch had been discharged the belt conveyor rig was again swung around to permit the next loaded truck to pass and back up into position for unloading. The operation of concrete placing was then resumed. With the belt conveyor rig illustrated, it took from 1 to 1½ min. for a truck mixer to discharge its 3½-yd. batch. With this equipment average progress, as previously noted, was 2,000 lin.ft. of 8-in. slab 10 ft. wide (500 cu.yd. of concrete) in 10 hours.

Finishing—Close behind the belt conveyor distributor came an Ord finishing machine which passed over the surface only twice, after which the final operations consisted of hand-belting and scoring transversely with a coarse broom.

At intervals of not more than 60 ft., transverse joints were formed with Carey premolded asphalt strips, placed with their tops 1 in. below the finished surface of the pavement. The upper 1 in. of the joint space was later poured with hot asphalt. The reason for not carrying the premolded joint strips up flush with pavement grade was to prevent their brooming out under traffic and forming transverse humps.

At each transverse joint, abutting slabs were anchored by steel dowel bars, one end of each bar being solidly embedded in the concrete and the other encased in a cardboard tube to prevent adhesion of the concrete to the steel and thus allow for movement caused by expansion or contraction of the slabs.

Curing—The curing of the slabs was done for the first 24 hours with moistened burlap and after that with a covering of hay, sprinkled periodically by means of a special watering cart, designed by the contractors. This cart, as illustrated, consisted of a steel tank mounted upon a motor truck chassis and equipped with a long horizontal perforated pipe, extending out at right angles across the slab and connected to the tank bottom by means of a swivel joint. It was possible, therefore, to swing the pipe out from either side of the truck or allow it to extend straight back so as not to form an obstruction when the truck was traveling from its filling point to the job. The same cart was employed, also, to wet down the subgrade prior to concreting.

The curing period was not limited to a definite number of days, but was governed by the strength of the concrete, as disclosed by tests of 6x6x30 in. beams, broken in a machine at the batching plant. As soon as the test beams developed a modulus of rupture of 500 lb. per square inch, curing was terminated and the pavement opened to traffic. Under this method of control the curing period was generally about 7 days, as compared with 14 days when an arbitrary time limit was set.

AT INTERSECTIONS grade-separating bridges are built and directional signs are placed to guide motorists.

BITUMINOUS SURFACING *(left)* 1 ft. wide is placed along sides of separating strip to widen inner traffic lane and serve as black guide line.

Separating Strip—After the inner strips of concrete pavement were completed Chelmsford granite curbing 8 in. high was set along the edges of the separating strip, and the intervening space filled with top soil and seeded. This detail was handled with a motor truck on which was mounted a Mead-Morrison truck crane which picked up the granite slabs, swung them out over the side of the truck and lowered them to place, as illustrated in one of the photographs herewith.

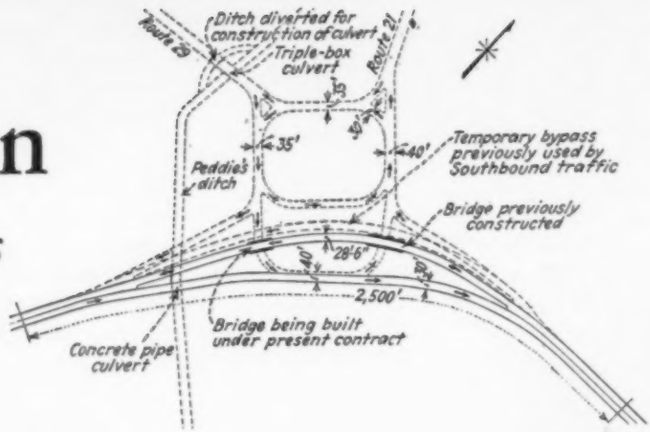
The final operations consisted of laying a strip of cold-mix bituminous surfacing 1 ft. wide between the inner lanes of concrete pavement and the separating strip and forming shoulders consisting of a 3-ft. width of macadam 4-in. thick adjoining a 7-ft. width of oiled gravel upon which cars can pull out for changing a tire.

Personnel—For the Massachusetts Department of Public Works, which designed and supervised the construction of the Boston-Worcester turnpike, Arthur W. Dean is chief engineer, F. D. Sabin, district engineer and W. F. Donovan, resident engineer at Framingham, Mass. For the contractors, B. Perini & Sons, Inc., of Ashland, Mass., John Doherty is general superintendent.

No Traffic Jams at This

Highway Junction

Built by Draglines and Trucks on Jersey Meadow Foundation



TO PREPARE a sound foundation for the pavement, bridge and culvert structures of an elaborate highway junction on the New Jersey meadows outside Newark, Wm. Eisenberg & Sons, Inc., of Camden, contractor, is removing the marsh mud to solid bottom and is building compacted earth fills to required elevation. A battery of power excavators dig the trenches to sound bottom and a large truck fleet hauls material for the fills from numerous borrows within a radius of 5 miles.

Design of Junction—An elaborate design was required to take care of the heavy traffic at this important junction, where two routes, one from the west and one from the north, will connect with N. J. 25 (U.S. 1), the main route between the south and the Holland Tunnel, linking Jersey City and New York. The junction includes a traffic circle with an additional relief road and two grade separations, as indicated by the plan above. By designing all roadways for one-way travel, the engineers eliminated crow-flow of traffic. Motorists can make left turns from one route to any other route without crossing an opposing line of traffic. This facility removes the greatest cause of traffic delays and makes it possible to utilize the connecting highways at something near their maximum capacity.

Construction Conditions—Route 25 must be kept open to traffic at all times during the construction of the junction. One of the two grade separation structures which ultimately will carry the southbound traffic of route 25 had been built under a former contract. When Wm. Eisenberg & Sons, Inc., began work on May 25, 1931, a temporary hard-surface roadway across this completed structure was carrying northbound traffic, and a second temporary hard-surface roadway on the west side of the grade separation structure was carrying southbound traffic.

Routes 29 and 21 have not been completed to the junction. Under the present contract, no pavement is to be laid on those parts of the junction connecting with these two routes. This pavement will be constructed under a subsequent contract to be let probably within a year.

Contractor's Plan—First among the problems of the contractor was that of removing 300,000 yd. of mud and placing 500,000 yd. of compacted fill on solid bottom. The average level of the meadows is approximately El. 8 and of the solid bottom of sea and clay is about El. —9. It was necessary to remove the 17 ft. of mud and to build up fills on the underlying bottom to an average depth of approximately 30 ft. and a maximum of 45 ft.

In the original attack on the problem, it was assumed that equipment could not be supported on the surface. This assumption was entirely reasonable, as was proved later when one of the power shovels sank out of sight in the mud. The contractor proposed to handle most of the excavation by unwatering the cut and operating power shovels on the solid bottom, the shovels to load into trucks which would haul up a ramp on the backfill. Clamshell excavators working on top of the fill were to remove the rest of the mud.

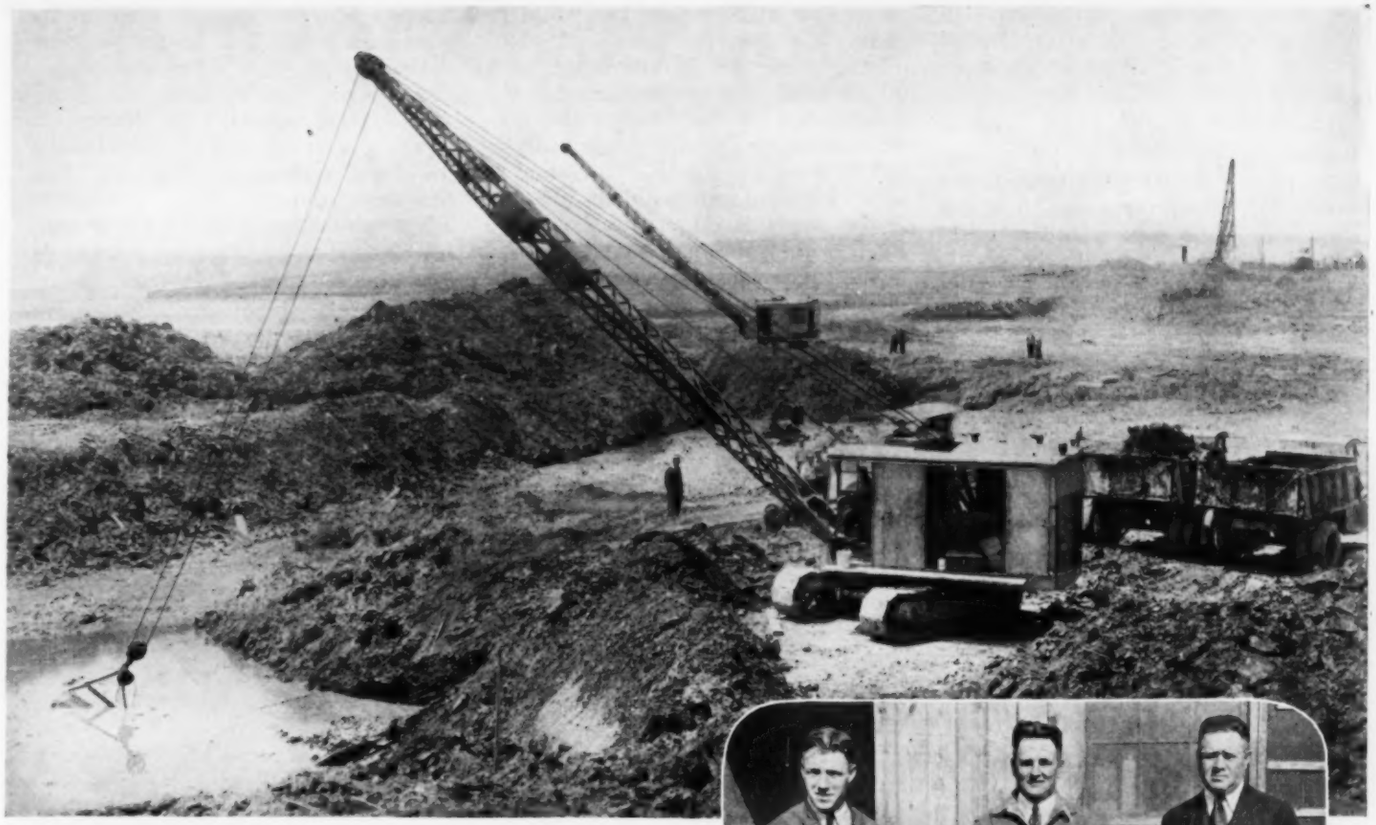
Unwatering the excavation would have presented small difficulty, as the meadow mud is impervious. The groundwater level is unaffected by tidal action. Pumps could easily take care of the surface drainage into the excavation.

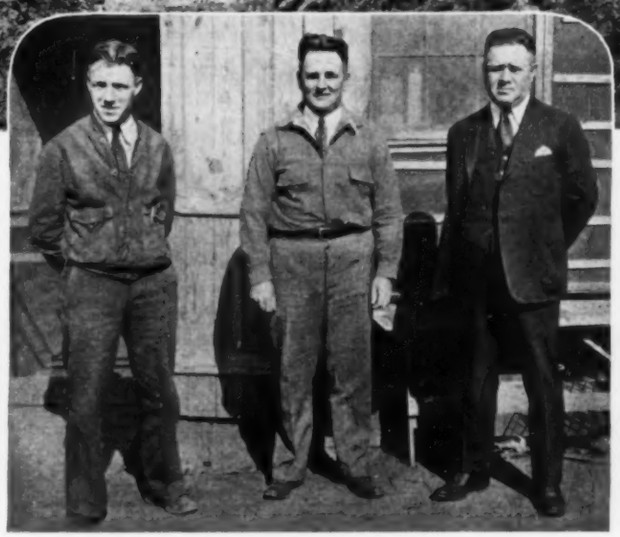
Unexpectedly good surface conditions at the site of the junction made it possible to use a more advantageous method than that originally proposed. Ashes, refuse and trash had been dumped for years over a large part of the site. These refuse dumps had formed a crust 6 to 8 ft. thick on the surface of the mud. By using this surface crust where possible and by rehandling the trash to form other supporting mats where needed, the contractor was able to handle most of the excavation from the surface with draglines. It was necessary to use a clamshell excavator as originally contemplated in several places.

Method of Operation—The procedure followed in excavating for the northbound roadway of Route 25 was typical of the method pursued on all parts of the job where draglines could be used. It was essential that the fill for the northbound roadway of Route 25 be completed as speedily as possible, as all traffic had to be diverted over this roadway before construction of the second grade separation structure could begin.

Width of the wet excavation for the northbound roadway was 140 ft. Covering the area to be excavated was a fill of ashes and trash 7 or 8 ft. thick. A power shovel stripped 4 to 5 ft. of this fill, leaving 3 ft. to carry the drag-

OLD FILLS at site of junction yield about 5,000 yd. of earth. Dragline converted into shovel with 1½-yd. dipper loads trucks on roadway 6 to 8 ft. above pit. Rest of 500,000 yd. of earth comes from borrows of 5,000 yd. or more within 5-mi. radius.





DRAGLINES, supported on trash crust of meadow, excavate mud to solid bottom, side-casting most of material and loading rest into trucks. I. EISENBERG *(extreme right)*, president, Wm. Eisenberg & Sons, Inc.; OSCAR VOGEL, resident engineer, and R. B. JAGGERD, contractor's engineer.

lines. Two 1¼-yd. draglines with 60-ft. booms began excavating at the north end and worked steadily south, side-casting most of the mud and loading the rest into trucks. The two draglines worked in parallel, each one following a line about 20 ft. in from the limit of the excavation. To speed the excavation as the draglines approached the south end, a third machine was put to work between the other two. The outside draglines then engaged in side-casting only, and the middle machine loaded into trucks.

Filling followed about 50 ft. behind the draglines. Trucks, hauling in from the north, extended the fill by end-dumping their loads, which were spread and compacted in 6-in. layers by a Caterpillar 10-ton tractor equipped with a bulldozer. By keeping the fill close to the draglines, the contractor was able to cut the banks of the trench to a steep slope without suffering much from slides and cave-ins.

Clamshell Method—A second fill demanding early construction was that for Route 29, on a part of the job which was covered with water. This fill had to be built before equipment could be moved in to construct the culvert for Peddie's Ditch, the stream shown on the plan. As equipment could not be operated on the surface, the contractor was forced to resort to a clamshell excavator working on top of the fill. A 1-yd. clamshell crane, advancing with the fill, excavated the trench to the required width, approximately 200 ft. The clamshell method had to be used in only one other place, on the south side of the traffic circle.

Draglines moved all the rest of the excavation, operating as already described except where the trench widened out to close to 200 ft. as required for high fills. In cutting to this width, two draglines excavated the trench in half widths, advancing about 200 ft. on one side and then returning to take out the other side. Fill was built close behind the draglines as they cut each half.

The draglines operated at a high rate of efficiency, each excavator moving as much as 1,200 to 1,500 yd. a day when side-casting. Two of the draglines were Bucyrus-Erie machines, one equipped with gasoline drive and the other with gas-air. The third dragline and the clamshell excavator were Koehring gasoline machines. At the start of the job, the clamshell crane was equipped as a 1-yd. shovel to strip and handle trash fill. About 8 mats, each 3x20 ft. in area, made up of 12x12-in. timbers, were used generally under the crawlers of each excavator.

Most of the excavated mud was wasted by spreading on the meadows, but 123,000 yd. was placed in the fill inside the traffic circle and in the triangular ditch between the slopes of the earth fill and of the wet excavation. From 6 to 8 ft. of water always was present in the excavation. The engineers of the state highway department used a boat to move about over the water, testing the condition of the bottom with a 2-in. oak pole.

Hauling—Sixteen trucks, ten 7-yd. Macks and six 3-yd. Autocars, disposed of the excavated mud and are now hauling most of the earth for the fill. The 7-yd. water-measure trucks carry 9 yd. of loose earth, equal to a pay load of 7 yd. of compacted fill. All trucks are equipped with pneumatic tires; the 7-yd. trucks have dual rear wheels.

Additional trucks are hired to enlarge

the contractor's fleet as needed. In building the fill for the northbound roadway, a fleet of 65 trucks delivered as much as 6,000 yd. per day.

Culverts—Peddie's Ditch crosses Routes 25 and 29. Four 90-in. concrete pipes conduct the stream under Route 25. These pipes had to be extended 96 ft. to pass under the northbound roadway. Wm. Eisenberg & Sons, Inc., drove 288 wood piles 20 ft. long to support the 384 lin.ft. of concrete pipe in the extension. The mud at the site was removed and replaced with earth fill before the piles were driven.

Construction of a triple-box culvert to pass Peddie's Ditch under Route 29 was sublet to the Linde-Griffith Construction Co., of Newark. Before the subcontractor could bring any equipment into this job, Wm. Eisenberg & Sons, Inc., had to divert Peddie's Ditch, excavate the mud at the site and build up earth fill on solid bottom.

The culvert, 150 ft. long, with three openings each 12 ft. wide by 14 ft. 6 in. high, required 2,250 yd. of concrete. A steel sheet-pile cofferdam was built to inclose the entire culvert and wing walls, and the reinforced-concrete structure was constructed inside the coffer. The Linde-Griffith Construction Co. drove 812 60-ft. wood piles as a foundation for the culvert. Concrete was delivered and mixed on the job in Jaeger truck mixers by Lambert & Co., of Newark, and was handled into the forms in a 1-yd. bottom-dump bucket by a Bucyrus-Erie steam crane. The piles were driven with two steam hammers, one operated in swinging leads by the steam crane and the other mounted on a conventional wood pile-driver, moving on rollers and equipped with a steam hoist engine.

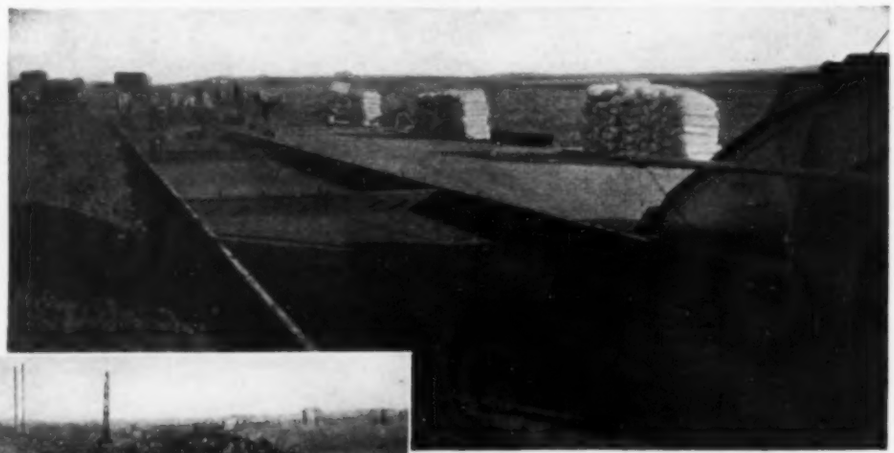
EARTH FILL is extended by end-dumping with trucks and compacting in 6-in. layers by tractor bulldozer. Borings taken at site of triple-box culvert show homogeneous earth fill extending to solid bottom at all points tested.

Grade Separation—The Linde-Griffith Construction Co. also is building the grade separation structure, with three concrete-incased girder spans (one of 35 ft. and two of 33 ft. each) and concrete piers and abutments, supported by 108 wood piles 60 ft. long. In preparation for the construction of this bridge, the general contractor followed the same procedure as at the culvert, excavating to solid bottom and building the fill above water level, approximately to El. 3. The subcontractor then moved in the equipment to drive piles for the pier footings.

Paving—To expedite construction of the northbound highway, Wm. Eisenberg & Sons, Inc., sublet the paving to Petrozzello Bros., of South Orange, N. J. All the general contractor's paving equipment was engaged on work in other parts of the state at the time. The pavement consisted of two 10-ft. lanes and two 5-ft. lanes of 10-in. concrete, approximately 2,500 ft. long, reinforced with two layers of 65-lb. welded wire mesh, one 2 in. from the bottom and one 2 in. from the top. Expansion joints filled with premolded material ½ in. thick were placed between the lanes and between curbs and adjacent lanes. Transverse expansion joints of the same thickness were spaced 34 ft. 4 in. apart.

In accordance with the standard practice of the general contractor and of the subcontractor, only one lane was paved at a time, with neither mixer nor trucks operating on the subgrade. It has been the experience of the contractors that they gain in economy by paving in single-lane widths, keeping the subgrade free from equipment. Grading was done by hand.

Sand and gravel were hauled in three- and four-batch trucks about 3 mi. from a plant in Elizabeth. For handling cement, the contractors adopted a method which is rarely used in this part of the country. Sacks of cement were stacked on wood pallets in advance of the mixer. Two cement handlers dumped seven bags for each batch into the skip of the Ransome 27-E paver operating on the subgrade.



BY PAVING ONE LANE at a time, contractor keeps equipment off subgrade and erects transverse joint strips in advance of mixer. Sacked cement is stacked on wood pallets ahead of paver.

Hand screeds, operated with a tamping motion by two workmen, one at each end, struck off the concrete for the wire-mesh reinforcing at two levels. The surface of the green concrete was scored transversely with a stiff broom to give the slab a uniform appearance and initial non-skid qualities.

To seal the surface during the curing process, Curcrete asphalt emulsion was sprayed on by an Iroquois gasoline-engined machine immediately after the brooming. At the end of 12 days, traffic was permitted to use the slab.

Administration—I. Eisenberg, president, Wm. Eisenberg & Sons, Inc., and H. Eisenberg, vice-president, maintain active contact with the job, making two or three round trips by airplane each week between Camden and the Newark municipal airport, ½ mile from the junction. Abraham Eisenberg, superintendent, is in charge of field operations, and R. B. Jaggard is the contractor's engineer. Under the direction of J. L. Bauer, state highway engineer, and R. M. Beck, division engineer, the preparation of plans was supervised by A. C. Lincoln, resident engineer in the division office, Newark, and operations in the field are directed by Oscar Vogel, resident engineer on the job.

HAULAGE COSTS CUT *by Contractor-Owned* LIGHT TRUCK FLEET

ASHLEY MERCER, truck foreman and mechanic, had charge of truck operation and maintenance and all other mechanical equipment on the job.

WHEN the West Construction Co. of North Carolina bought a fleet of light trucks last spring to do all of the hauling on extensive sand-asphalt paving contracts in that state, instead of subletting this part of the job to haulage contractors, there was a good deal of skepticism from various directions as to the outcome. Even A. K. Barrus, president of the company, knew he was experimenting to some extent. But he had his convictions about what he could do, which experience on about 25 mi. of work last season proved were right.

This plan of the company doing its own hauling saved a considerable percentage of the cost of moving materials. But what was more important, the company-owned fleet of trucks permitted the whole layout of plant and equipment on the several jobs to be worked constantly during favorable weather practically to top capacity. This meant that the asphalt plant, which was at a fixed location and involved several times the investment that was made in the trucks, never had to hold a batch until a truck arrived to take it. Out on the grade the finishing gang, with their screed and rollers, were kept going steadily.

PART OF FLEET of twenty 1½-ton trucks on an idle day. Canvas covers for asphalt loads are placed over hoods when trucks are not working.

CY RHODES, grade foreman for the West Construction Co., of North Carolina.

When a representative of *Construction Methods* visited the plant near Kinston, down in the sandy, flat coastal plain section of North Carolina, an 18-ft. sand-asphalt job about 3 mi. long was being finished. Prior to that the company had in 1931 built from this same plant set-up about 30 mi. of this type of work for the state highway department, and about 2,000 sq.yd. of paving of this type in Kinston. Included in the state work was a continuous stretch of 26 miles that started near the plant.

There was thus an opportunity to try the company-owned truck fleet idea on a wide variety of hauls. On the 26-mi. job the savings were gratifying. Even on the short haul for the 3-mi. job near the plant there was a big reduction in cost of moving the mix from the plant to the grade. But the most important result was that the jobs were all speeded up by having enough of the right type of trucks under the complete control of the contractor, so that they could be operated to suit the constantly changing needs and conditions.

The fleet consists of twenty 1½-ton standard Chevrolet truck chassis units each carrying a 2-yd. steel dump body equipped with a mechanical hoist driven by a take-off from the transmission shaft of the truck. The hoists and dump bodies were built by the Hughes-Keenan Body Co., Columbus, Ohio.

Based on long previous experience with truck haulage, the company recognized from the start that the whole fleet would have to be kept in just as

nearly perfect mechanical condition as possible. To this end, inexpensive, but well-equipped shop and garage facilities to take entire care of the servicing and repairs of the fleet were provided near the mixing plant. An experienced automotive mechanic was placed in charge of these facilities. Each driver was, however, made entirely responsible for his truck. Bonuses rated on weekly and seasonal results also were paid the drivers, these being based on various factors. Finally, a truck overseer provided with a light car was employed to keep constant check on the movement of the trucks and the work of the drivers.

Underlying the truck operation policy was the recognition that there should be in service just a little more than enough truck capacity to keep the asphalt plant running at the right speed. In other words, if there was any waiting to be done, the trucks would do it. Neither the asphalt plant nor the finishing gang was ever required to wait for truck service.

This policy of surplus transportation units was based on the long recognized experience of successful earth-moving contractors. They never permit a shovel to wait for haulage equipment. Mr. Barrus considers that the situation is exactly the same on a paving job, and particularly on one that requires a large investment for plant, such as a sand-asphalt contract does.

On the other hand, the haulage contractor naturally has just the opposite viewpoint. His interest is to get the material moved with the least possible investment in trucks. He believes he cannot afford to keep surplus trucks on the job. Usually he leans the other way and has too few trucks to permit the plant to run regularly. Hence, the plant and equipment of the main contractor frequently wait for the subcontractor's trucks.

All of these troubles were eliminated with company-owned trucks. Moreover, it was possible to keep much closer control over the company's own drivers than over the men of a subcontractor doing the haulage. For example, on the 26-mi. job it was necessary to run over the finished grade and the pavement base. In order to avoid ruts, a scheme was worked out to keep the trucks spread over the width of the road. Each driver was daily given instructions as to the position he was to follow on his out trip. One man would be placed on the right-hand side of the grade, the next the right center, the next the center and so on across the grade, the loads having the right of way and passing being done on the left-hand side when necessary. With the overseer it was possible to keep the trucks quite accurately in their proper position. A minimum spacing of 100 yd. between trucks also was easily maintained. The bonus system helped a lot.

The points on which the bonuses were based involved all the angles of the job that would make for efficiency and safety. In the first place, to be eligible the driver had to haul the maximum tonnage fixed for each day. The mechanical condition and the appearance of his truck were the next most important factors. Freedom from accidents, lack of interference with other trucks and general adaptability to the rest of the operations on the job also were considered.

The bonus winner each week got an extra day's pay for that week. The second place man got 60 per cent and the third place man 40 per cent of a day's pay. The driver having taken the best care of his truck during the entire job got ten days extra pay at the end of the job, the second place man got six days extra pay and the third place man four days.

Bonus awards were made by the plant superintendent, the truck overseer and the grade foreman serving as

TRUCK NO.	PAYROLL	MILEAGE	TONS HAULED	HOURS	GASOLINE	OIL	GREASE

HEADINGS FOR REPORT FORM which is filled out each day by the truck foreman to enable truck performance to be checked ac-

READY FOR INSPECTION. *(Left to right)*, ALLEN WOOTEN, state highway inspector; A. K. BARRUS, contractor; ED WELLS, inspector; CLYDE JONES, asphalt road foreman, and HEBER GRAY, inspector.

IN FRONT OF SHOP, JOHN D. WALDROP, state highway construction engineer, confers with A. K. BARRUS, president of West Construction Co.

REPAIRS		TIRES		OVERHEAD		TOTAL COST	COST PER TON
Mechanic	Parts	Repair	Replace	Insurance	License		

curately. On the report are included consolidated operating figures for the whole truck fleet and also figures for the previous day.

a committee. There was never the slightest questioning of their decisions and every man was out to win. Most of the men washed their trucks every night, provision being made at the plant so this could be done easily. The drivers checked their motors and mechanical plant constantly. They also kept close tab on their tires and wheels.

Regardless of conditions, the company policy was to change cylinder oil every 500 mi. Similarly, greasing was done more frequently than is common practice. Refueling was worked out on a mileage basis so there was no risk of empty tanks on the road. All these things the drivers watched very closely to keep in line for the bonuses.

As a check on operations a haulage ticket in triplicate was made out at the plant for every load. The plant foreman kept one copy of this, the truck driver took the second and turned it over at the dumping point to the foreman there. The third copy remained in the office as a check. Throughout all of the work these tickets never failed to match up at the end of the day.

An accompanying illustration shows the heading of a truck report that was made out daily by the foreman and approved by the superintendent. On this report each truck's record for that day for the items covered by the report was recorded. The day's report also gave that day's totals for the job for these items. For ease of comparison the totals of the previous day and of the job to date also were given.

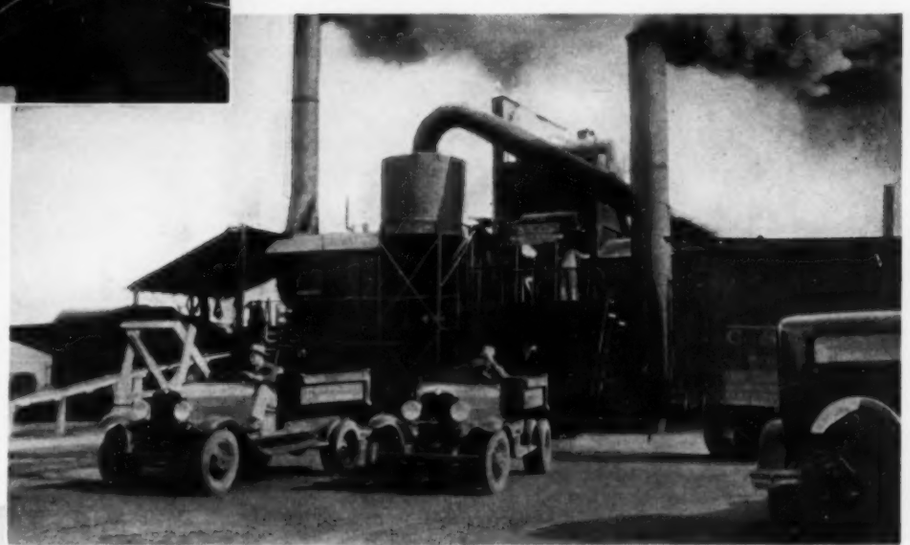
With this report it was possible to keep an accurate check constantly on every truck in service. At the same time, the costs of the hauling could be figured closely by merely adding a fixed rate of depreciation and obsolescence. If any truck or any day was out of line, the figures quickly made it possible to spot the discrepancy.

At the time these notes were prepared, the twenty trucks had been run more than 534,000 or an average of about 27,000 miles per truck. Inspection of several of them indicated they were in excellent condition. Operating expense per mile per truck also had not increased over the rate of the early part of the season. There had been practically no replacements of parts and no trucks out of service for major repairs. The original tires were still in use, with apparently much mileage in them.

Unquestionably the very close supervision of the trucks and the bonus system enabled the results mentioned to be obtained. Certainly, the operating conditions were not particularly favorable, since the trucks made much of their mileage over earth surfaces and new grading. A cruising speed of 35 mi. an hour also was enforced on all operations. Faster construction of both 3-in. base and 2-in. top coat resulted from the increased efficiency of truck service.

The paving contracts served by the fleet of light trucks were built under the supervision of L. R. Ames, state highway engineer of North Carolina.

DRIVER GETS TICKET, but only as a means of checking his truck load for the day's run. One copy remains in office, one at asphalt plant and driver turns third copy over to grade foreman.



TRUCKS LOADING at asphalt plant. As one truck leaves, another is ready to back in. Driveway paved from plant to road.

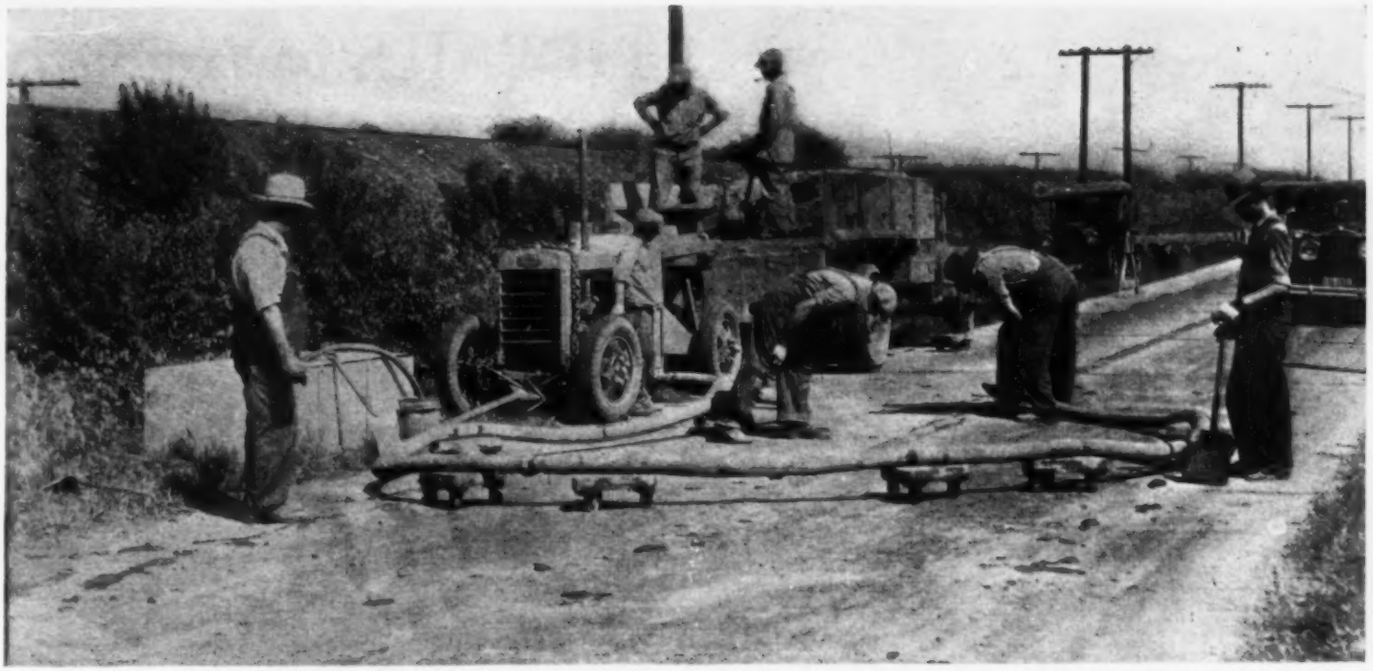
GARAGE and shop facilities for truck fleet are inexpensive. Buildings are, left to right, office, supply house, shop and repair shed.

Getting Down to DETAILS *of Highway Maintenance and Construction*

FOR SMOOTHING ROUGH PLACES and cutting down high joints in concrete roads, an air-operated hammer drill is mounted on a small wheel carriage. Unusually broad bit on drill steel measures 3½ in. across face. *Photo from* J. J. FORRER, *assistant engineer of maintenance, Virginia Department of Highways.*

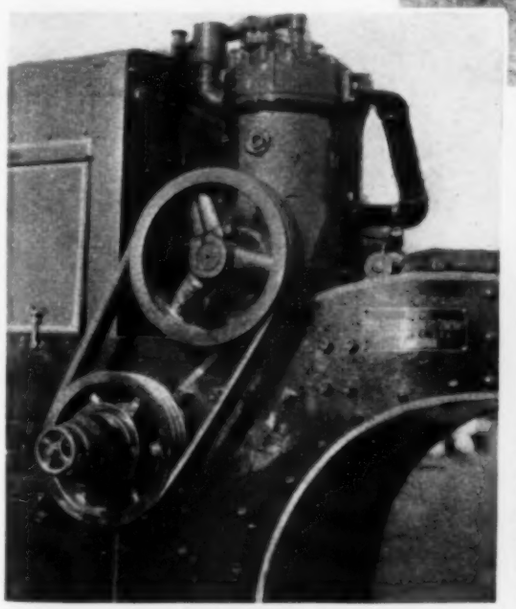
POST PULLER *(left)* is rigged to body of motor truck in such a way that when heavily weighted truck body is lowered from dumping position, boom rises and extracts post.—*Photo from* A. H. HINKLE, *superintendent of maintenance, Indiana Highway Commission.*

MECHANICAL SPREADING of chips and crushed stone is regularly practiced in construction and maintenance of highways in Pennsylvania. At left, stone for Route No. 209 in Dauphin County is being distributed by mechanical spreader on rear end of motor truck. At right, spreader box insures even application of chips to surface of route No. 137 in Lancaster County.—*Photos from* SAMUEL ECKELS, *chief engineer, Pennsylvania Department of Highways.*



MUD JACKS are a new development in maintenance work for raising sunken slabs of concrete pavement. Holes are drilled through pavement and mud pumped through hose line to bring concrete surface to correct grade.—*Photo from* FRANK T. SHEETS, *chief highway engineer, Illinois Division of Highways.*

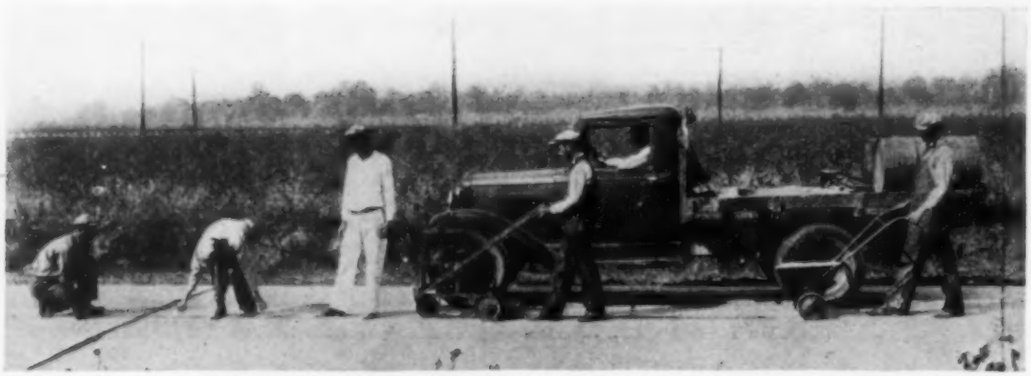
FOUR-BOTTOM GANG PLOW *(right)* is used with disk harrows to prepare mixed-in-place sand-asphalt base for pavement. Sand, placed on subgrade to depth of 6 in., receives two applications of cut-back asphalt and is disk-harrowed. Gang plow then turns over mix and disking continues. After surface has been shaped and compacted by traffic, binder coat of hot asphalt (0.4 gal. per square yard) is applied, covered with ¼- to 1¼-in. stone and rolled. — *Photo from* CHARLES H. MOOREFIELD, *state highway engineer of South Carolina.*



DUAL PURPOSE is served by installing 110-cu.ft. air compressor on 8-ton road roller. Unit, belt-driven by gasoline engine of roller, when latter is idle, supplies air to paving breakers on bituminous patching work. When stone for patch is placed, roller compacts it and smooths surface.—*Photos from* G. H. DELANO, *maintenance engineer, Massachusetts Department of Public Works.*

Additional Details on Next Page

DETAILS *of Highway*



BLACK CENTER LINES WITHOUT "WOBBLES," are painted on concrete roads by the equipment shown in the two illustrations above. Crew uses a cut-back asphalt covered with a light coat of sand applied by special sand-spreader *(at left)*. By blotting freshly painted stripe with sand, center line is not tracked by traffic. This method gradually builds up a surface-treated center line that requires fewer renewals each year it is painted. During 1930 cost of black center lines averaged $25.65 per mile of line. During 1931, cost was reduced 20 per cent by use of improved methods and cheaper paints.—*Photos from* CHARLES H. MOOREFIELD, *state highway engineer of South Carolina.*

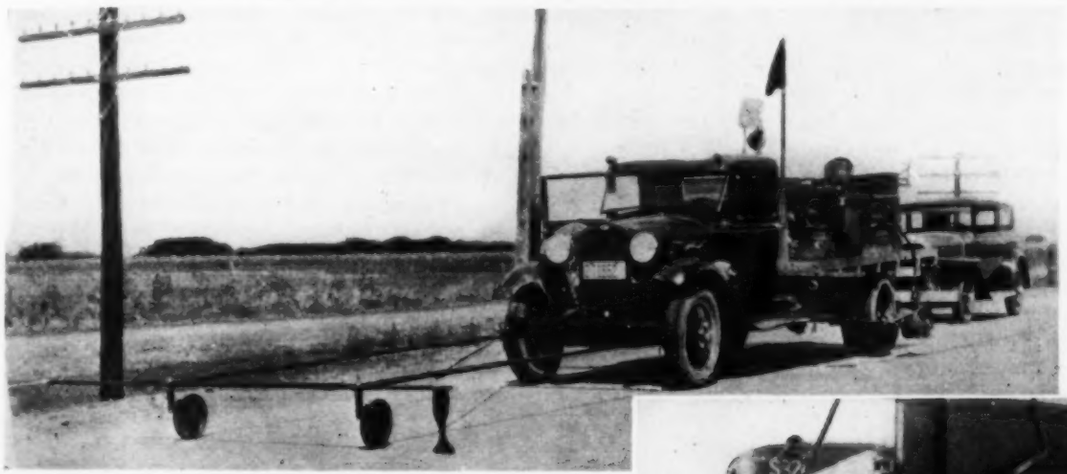
SNOW REMOVAL has become an important part of the duty of the maintenance division of a state highway department. Here is a machine that has proved effective in cutting through the big drifts prevalent in Montana. It consists of a rotary snow plow rigged on the front end of a truck and operated by an auxiliary motor.—*Photo from* R. P. NEWLAND, *maintenance engineer, Montana Highway Department.*

"SECOND-STORY WORK" repaired this 1½x3-ft. culvert washed out underneath concrete pavement by abnormally large runoff. Pavement *(upper photo)* was propped up before it failed and instead of attempting to replace the fill, with probability of settlement and subsequent cracking of pavement, a second story was added to the culvert *(lower photo).—Photos from* J. P. DONOVAN, *maintenance engineer, Colorado Highway Department.*

PORTABLE COOK HOUSE on wheels used by Minnesota Highway Department crew operating mud jack to raise sections of pavement depressed by settlement of subgrade.—*Photo from* C. M. BABCOCK, *Commissioner of Highways, Minnesota.*

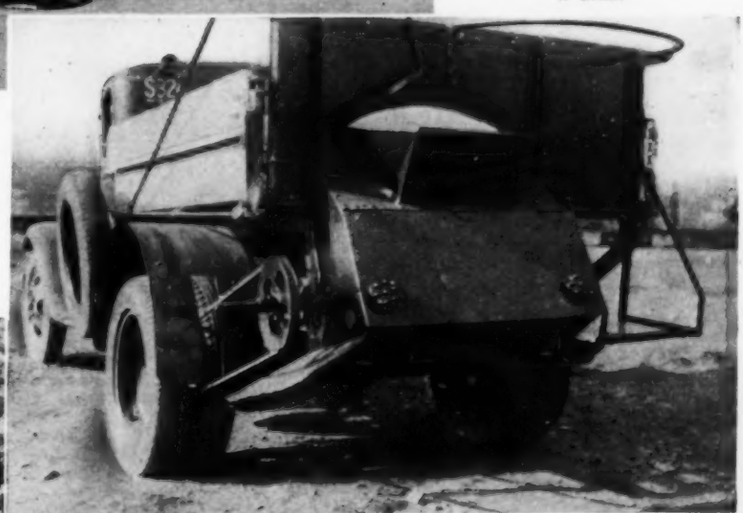
Maintenance and Construction

FOR MOWING WEEDS along highways George Huntington, section foreman, developed this machine, consisting of two-wheel frame carrying power-driven sickle bar at end of telescoping pipe from motor truck. Sickle bar, driven by independent motor, operates at any angle and reaches out of the way places.—C. M. BABCOCK, *Commissioner of Highways, Minnesota.*



SANDING *(below)* of slippery street surfaces is done by spreader attached to rear end of truck in place of tail gate. Sand falls from truck, through chutes controlled by slides, upon a pair of "spinners" which spray the material on the road. Truck speed governs spread of sand spray. — *Photo from* G. H. DELANO, *maintenance engineer, Massachusetts Department of Public Works.*

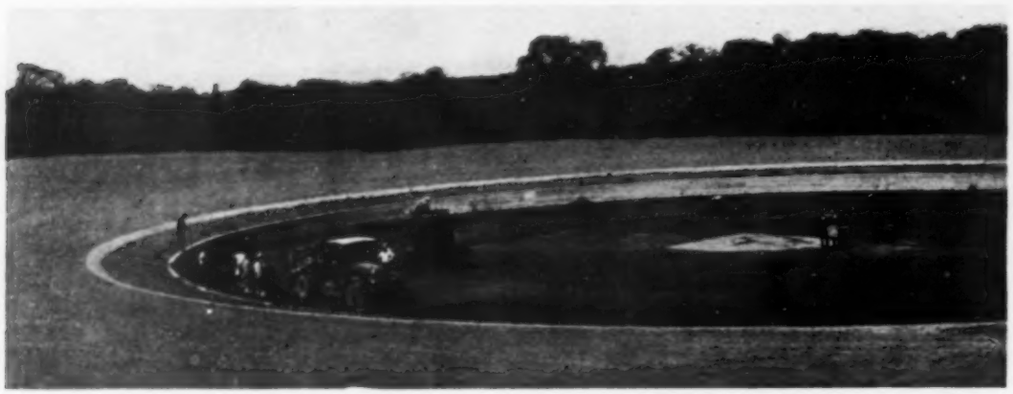
CENTER-LINE MARKING EQUIPMENT used by Nebraska State highway department. Outrigger on front end of truck enables driver to follow accurate line.—*Photo from* A. T. LOBDELL, *chief, Bureau of Roads and Streets, Nebraska Department of Public Works.*



ELECTROMAGNET ROAD CLEANER *(left)* removes tire-puncturing metal from Michigan roads. Trailer machine consists of gasoline motor driving d.c. generator connected to electro-magnets which are mounted inside plates forming cylinder 8 ft. long. As trailer moves forward, cylinder revolves close to ground picking up metal from road. Cylinder plates at top of travel are demagnetized by commutator allowing metal débris to fall into trough.—*Photo from* GROVER C. DILLMAN, *State Highway Commissioner of Michigan.*

ASPHALT PAVING

Used to Line Reservoir Bottoms



METHODS and materials ordinarily employed in the construction of sheet asphalt pavements have been applied to a different use in forming watertight linings for the floors of three reservoirs completed recently on a Long Island estate in New York. As part of the landscape treatment for the grounds and to accommodate flocks of ducks and provide for the growth of aquatic plants, the White Construction Co., of New York City, was engaged to build three ponds, one of them circular, with an inside diameter of 200 ft., and the other two rectangular, each measuring 100x200 ft. in plan. The maximum depth of water in the ponds is 5 ft.

The design for the circular pool, described in these notes, provides for paving the earth side slopes of the basin with concrete slabs 8 in. thick at the center and building a vertical circumferential wall of concrete about 3½ ft. high at the base of the slope paving to retain a wedge-shaped section of fill for aquatic plant growth. The slope lining is cast in slabs 32 ft. wide, separated by expansion joints.

The floor of the circular pond is paved with a 3-in. thickness of Texaco sheet asphalt, consisting of a 1½-in. top course and a 1½-in. binder course. The paving is laid directly upon a crushed stone base course 4 in. thick. Because the asphalt linings will be under a 5-ft. head of water, it was considered advisable to insure watertight-

ASPHALT FLOOR LINING material for circular reservoir is delivered by trucks and raked smooth before compaction by 12-ton roller.

DRAINAGE, during construction, was obtained by paving from outside toward center, leaving area of unpaved stone base to carry off rain water.

TANK TRUCK heats asphalt for seal coat of reservoir bottom lining.

TORPEDO GRAVEL is spread upon seal coat of hot asphalt.

ness by introducing into the mixture a much higher percentage of asphalt than is common in street paving practice. For the top course the mixture is exceptionally rich, containing 12 per cent of asphaltic cement, as compared with about 7 per cent in street paving mixtures. The binder course contains 4½ to 5 per cent of asphalt. For both courses a 65 penetration asphalt is used. After rolling, the top course receives a seal coat of hot asphalt upon which is spread a thin layer of torpedo gravel.

The paving of the pool floors was done under a subcontract with the Andrews Road & Supply Co., of Mineola, L. I., which delivered the hot mix from its plant at Roslyn, 4 miles distant.

Excavation for the three ponds was done with tractor-hauled scrapers. Upon the prepared subgrade was laid a 4-in. layer of crushed stone of 1½-in. size, compacted by rolling. Into the interstices in this stone base sand was brushed until a smooth, solid surface was produced. Upon the stone base the 1½-in. course of asphaltic binder was spread by hand shovels and rolled with a 12-ton roller. The work was started at the perimeter of the circular reservoir where a ring from 25 to 30 ft. wide was paved first. Subsequent paving was carried on in concentric bands, thus always leaving at the center an unpaved area of stone base through which rain water could be drained.

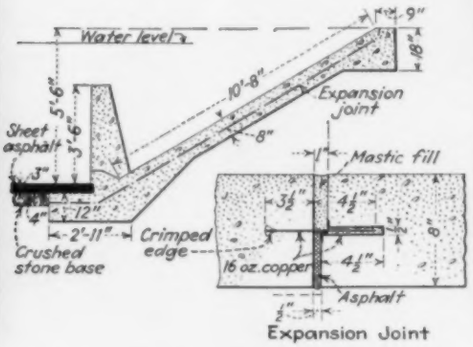
Before paving was begun there was some doubt as to whether the excessively rich top course, with its soft, almost "sloppy," consistency, due to the presence of a large percentage of asphalt cement, could be compacted properly with a 12-ton roller. Experience developed no difficulties in the rolling process.

Truck-loads of the hot asphalt paving mixture were driven down a plank ramp into the reservoir area and dumped upon metal pans, from which the material was shoveled into place, raked to a level surface and then rolled by a 12-ton roller. Asphalt for the seal coat was heated in a tank truck, distributed in hand buckets and squeegeed. The final operation consisted of covering the seal coat with torpedo gravel at the rate of 30 lb. per square yard and giving the surface one more rolling.

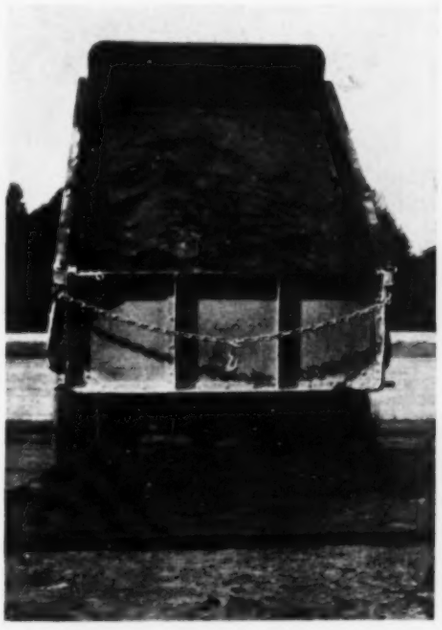
For the White Construction Co., the field work was directed by F. W. Narr, superintendent.

F. W. NARR, superintendent for White Construction Co.

LONG HANDLED TAMPER compacts asphalt floor lining along base of circular side wall.



EXPANSION JOINT, with mastic filler, has copper sealing strips to prevent leakage.



CONSISTENCY of paving mix was "sloppy" due to high percentage of asphaltic cement.

Ohio Contractor Distributes Cement Along Subgrade for

BASE COURSE OF BRICK PAVEMENT

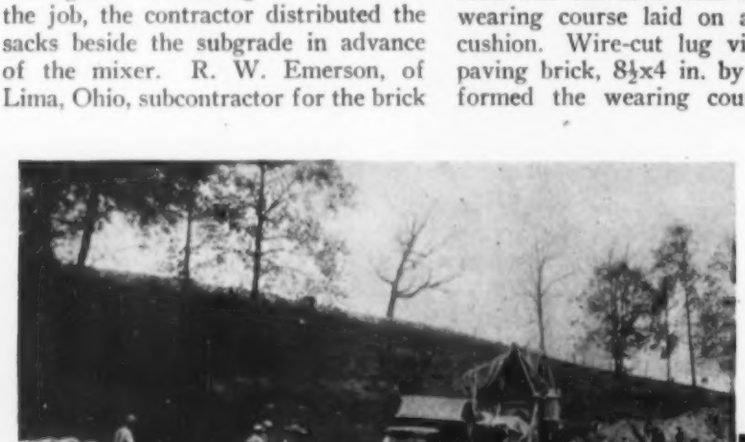
THREE-BATCH TRUCKS haul weighed aggregates from gravel company's plant. Two men dump sacked cement into mixer skip.

DIRECT hauling of materials from the manufacturers' plants to the point of use on a 9.74-mi. brick-and-concrete road job in Ohio obviated need for a material-handling plant and eliminated freight and rehandling charges. By adding to the truck fleet ordinarily used for a job of this size, Ray Strawser, Inc., of Columbus, contractor, hauled batched aggregates from the producer's yard and cement from the mill. Instead of storing and rehandling the cement on the job, the contractor distributed the sacks beside the subgrade in advance of the mixer. R. W. Emerson, of Lima, Ohio, subcontractor for the brick paving, followed similar practice in hauling from the manufacturing plant and stacking brick along the shoulders of the road.

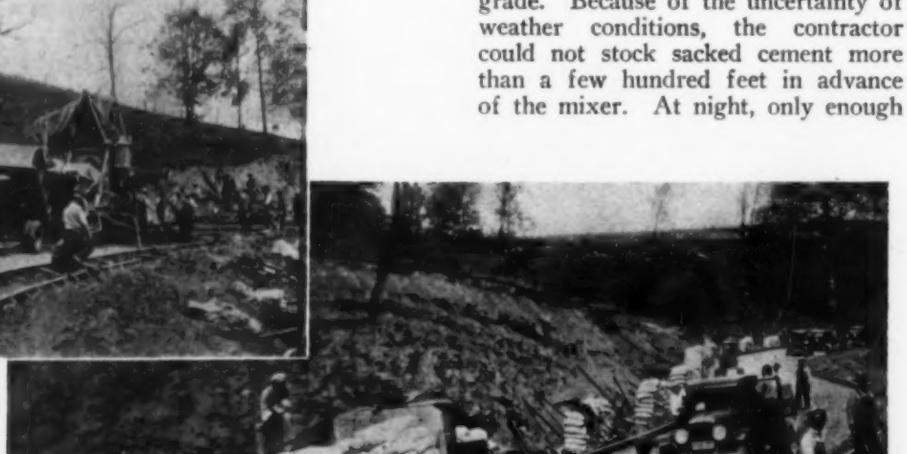
Description of Job—Numerous steep grades and sharp curves occurred in the project, which extended in a southeasterly direction from Chandlersville to Cumberland. The pavement consisted of a 6-in. concrete base 20 ft. wide, with integral curbs 12 in. wide and 3½ in. high. Between curbs the road was surfaced with a 3-in. brick wearing course laid on a ¾-in. sand cushion. Wire-cut lug vitrified shale paving brick, 8½x4 in. by 3 in. thick, formed the wearing course on this 18-ft. width. The joints were filled with hot asphalt.

All materials were hauled in to the job from the west end. The contractor followed usual practice in concreting the west half of the job first, thus providing 5 mi. of pavement for hauling to the east half. Starting at about the middle of the job, the mixer worked west to Chandlersville and then moved to the east end and paved west from Cumberland.

Material Handling—A fleet of three (and sometimes four) 5-ton trucks, hauling 120 sacks each, and a crew of four men, two to unload the trucks and two to dump the cement into the mixer skip, sufficed to handle all cement used on the job. Length of haul from the cement plant was 30 miles. The sacks were unloaded and stacked on wood pallets along the subgrade. Because of the uncertainty of weather conditions, the contractor could not stock sacked cement more than a few hundred feet in advance of the mixer. At night, only enough



FALSE FORMS carry finishing machine around many widened curves on job.



SACKED CEMENT is hauled 30 mi. from mill and is stacked on wood pallets outside subgrade.

cement was left covered by tarpaulins to run the first hour in the morning. By the use of this small truck fleet for hauling cement, Ray Strawser, Inc., eliminated railroad and transfer charges and reduced the payroll for cement handling on the job.

In a similar way, the contractor effected a saving by hauling concrete aggregates from the gravel company's plant at Zanesville, 12 miles from the west end of the job. Batch scales for measuring sand and gravel were attached to the storage bins at the gravel company's plant.

Brick Course—As soon as concrete in the first section of the base had cured sufficiently, R. W. Emerson started hauling brick on to the east part of this section, stacking them along the shoulder. Brick surfacing operations were started promptly and were continued until trucks began hauling over the pavement to the east end of the job. Mr. Emerson's crew suspended work while hauling was in progress and resumed operations when the concrete base had been completed.

Brick were laid on the area, 18 ft. wide, between curbs. Sand for the cushion first was dumped on the base, and, after spreading, was struck off to ¾-in. thickness by a manually-operated templet riding on the curbs.

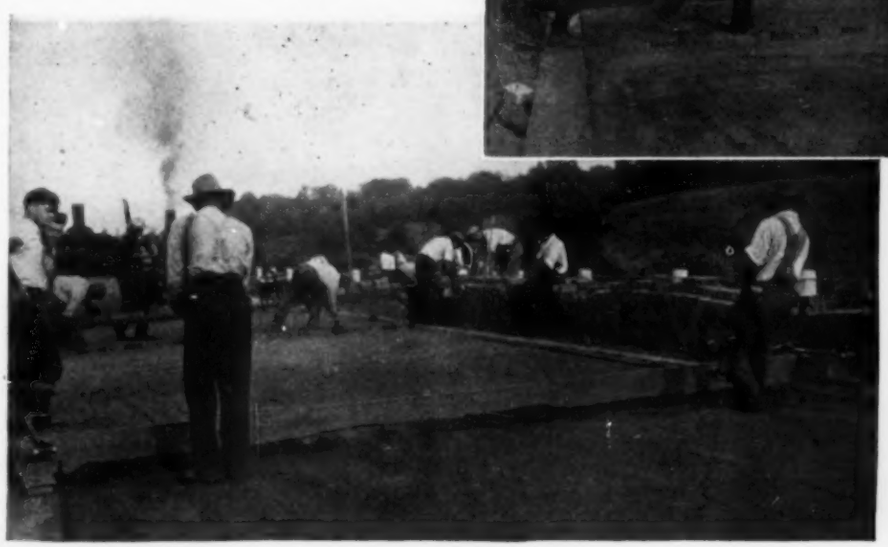
A Mathews roller conveyor delivered the brick to the droppers. Five men fed the conveyor, and three droppers placed the brick on the sand cushion. This crew averaged about 700 ft. in 8 hr. Greater speed could be made when the brick were piled on the side from which the droppers started. A few brick then could be placed on the starting curb, saving a little time over delivering all the brick by conveyor. When working at top speed under favorable conditions, the crew could run 1,000 ft. in 8 hr. A 5-ton steam roller bedded the brick in the sand cushion.

5-TON ROLLER beds brick in sand cushion. Squeegee pot spreads asphalt joint filler.

Asphalt filler for the joints was heated in a Littleford 500-gal. coal-burning kettle and was distributed by a hand-operated squeegee pot on wheels. The lugs on the brick assured even spacing of the joints and simplified the task of keeping the brick courses in alignment. After the joints had been filled, sand was swept over the surface of the pavement to absorb excess asphalt and prevent a sticky surface objectionable to traffic.

Administration—Under O. W. Merrell, director of highways, H. P. Chapman, chief engineer, and Elmer Hilty, chief engineer of construction, the job was managed for the state highway department by B. H. Frasch, division engineer, and John Dennis, resident engineer. For Ray Strawser, Inc., H. A. Brooks, superintendent, directed operations. F. M. Emerson, superintendent, was in charge for R. W. Emerson.

ROLLER CONVEYOR fed by five men delivers brick to three droppers. Crew averages close to 100 ft. of 18-ft. brick surface an hour.



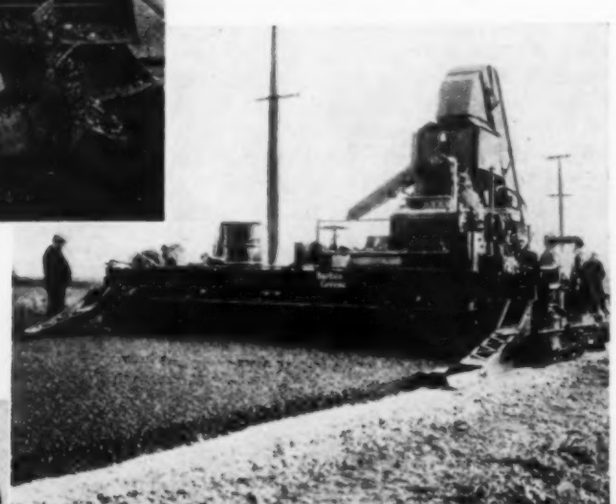
WOOD TEMPLET resting on curbs is pulled forward by two men to strike off sand cushion to ¾-in. thickness.

Bituminous Roads Machine-Built in CONTINUOUS OPERATION

ON AN OLD gravel road 1 mi. long near Aurora, Ill., a new machine, consisting of two independently operated units, a loader-mixer and a spreader-tamper, recently gave a demonstration of applying in a continuous operation a cold-mix bituminous surfacing 20 ft. wide with a compacted thickness of 2½ in. and a crown of 1½ in. After the road had been primed with tar, washed gravel was distributed from spreader boxes in a long windrow down the center of the road, leaving traffic lanes on each side.

Without resort to side forms, construction was started by the loader-mixer unit, consisting of a bucket elevator with spiral type pick-up feeder, storage hopper, spray chamber and twin pug mill. This machine, mounted on crawler treads, worked into the gravel windrow, picking up the aggregate and delivering it, via the hopper, through a calibrated gate to a spray chamber, where it was sprayed with cold bituminous material. From this chamber, the material entered the pug mill, a revolving-blade open mixer of the continuous type. After thorough mixing, the material passed to the spreader-tamper for application to the old road surface. The spreader-tamper, also crawler-mounted, spanned the road behind the loader-mixer and delivered the mix uniformly across the surface of the highway by means of horizontal screw conveyors. Consolidation was done by a double-action tamper having a face 1½ in. wide, divided into two steps, ¾ in. wide and ¾ in. deep. Next came a screed 6 in. wide, operated one-half cycle behind the tamper oscillations, so that the material was "tucked" under the screed at the top of its stroke. The spreader-tamper is adjustable for different thicknesses of road, crowns or super-elevations while the machine is running. The elapsed time from the picking up of the gravel aggregate to the compacting of the finished road surface amounted, as a general rule, to about 2 min.

The work was done under the supervision of E. L. Gates, county superintendent of highways, and Horace Jones, mechanical engineer of the Barber-Greene Co., of Aurora, Ill., which developed the new bituminous paver and finisher.



CONTINUOUS BITUMINOUS SURFACING is applied cold by new two-unit machine, consisting of mixer-loader *(above, left)* and spreader-finisher *(above, right)*. Pug-mill type of mixer *(top)* has revolving blades. Train of operations is illustrated in lower picture. Tank truck feeds bituminous material to crawler-mounted plant.

HAULAGE SAVED

by Mixing Bituminous Surfacing in Portable Plant at Gravel Pit

MIXED hot in a portable plant set up at a gravel pit 3 mi. from town, asphaltic gravel surfacing was applied last summer by Claude B. Talbot, Detroit contractor, to eliminate the dust nuisance on 50,000 sq.yd. of plain gravel streets in Rochester, Mich., a village of 5,000 population. Preliminary work included drainage structures at intersections and grading existing streets to provide for a course of asphaltic gravel 2½ in. thick after compaction by rolling.

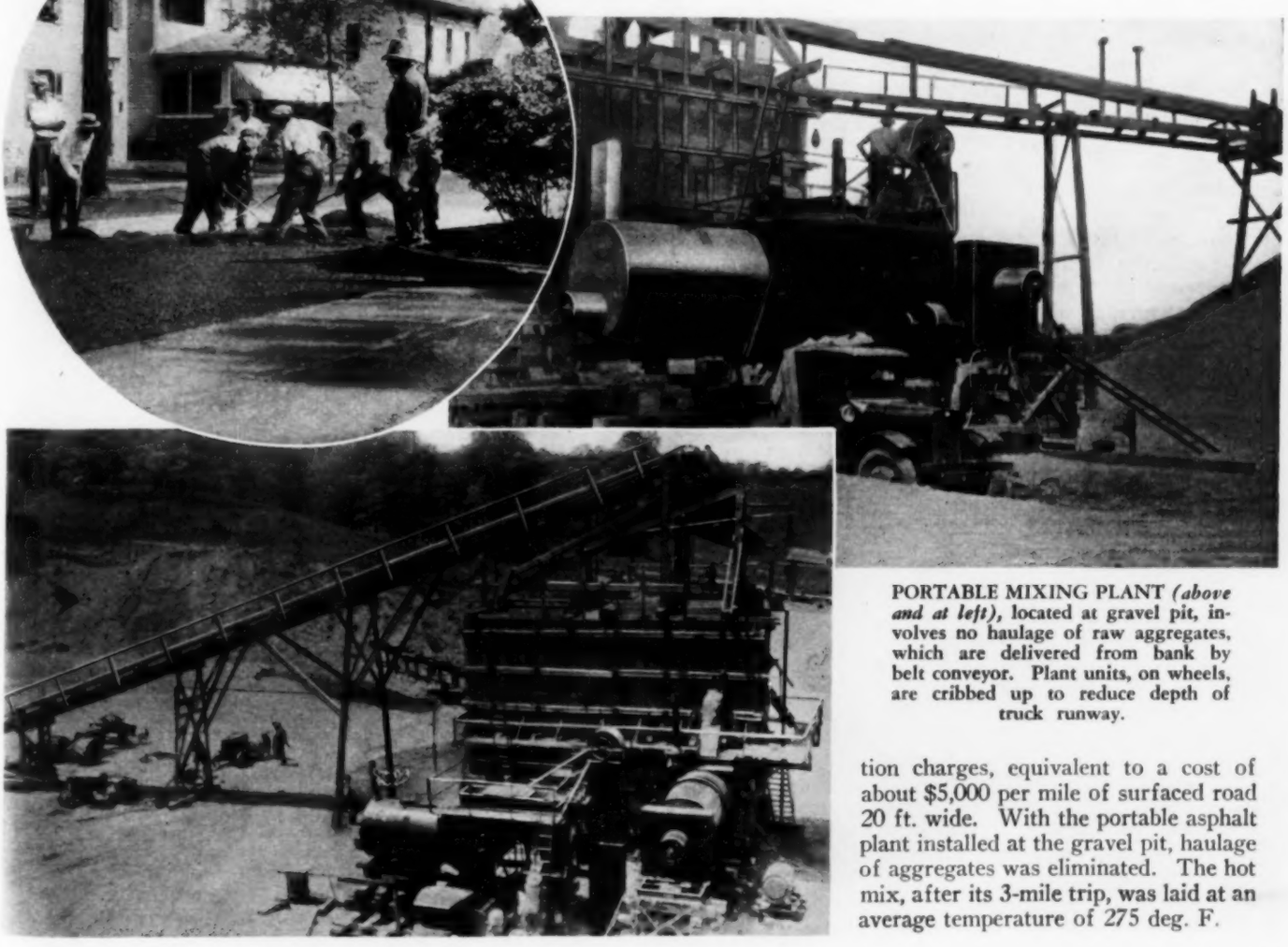
From the pit gravel was delivered by a belt conveyor to screens which excluded sizes larger than ¾ in. Mixing was done in a Chausse portable asphalt plant consisting of two units, a drier and a continuous pug-mill blade-type mixer, both mounted on rubber-tired wheels for transport from one set-up to the next. After passing through the rotating drier, the aggregate, heated to 300 deg. F., was carried by an elevator delivering to a measuring device on the mixer unit to which asphalt, heated in a 950-gal. tank, was pumped. For the Rochester job, the percentage of asphaltic cement in the mix was from 5 to 6.

From the pug mill the hot stuff dropped into a storage bin with a bottom gate operated by the drivers of the trucks which delivered the material to the job. In the accompanying photographs it will be noted that the plant is supported on cribbing. This was necessary because a high ground water level at the gravel pit prevented digging a deeper runway for loading the trucks.

The contractor's force at the mixing plant and on the surfacing work consisted of: 1 foreman, 2 plant operators, 1 fireman for tank-car heater, 1 driver of truck carrying asphalt from cars to plant, 1 form setter, 4 shovelers and rakers, 1 roller operator and 2 watchmen. In addition, the gravel, supplied under subcontract, required 2 men at the pit and 4 truck drivers to deliver the hot mix.

With the plant described, the cost of the asphaltic gravel surfacing was about $3 per ton laid and rolled, including labor, material, interest and depreciation charges, equivalent to a cost of about $5,000 per mile of surfaced road 20 ft. wide. With the portable asphalt plant installed at the gravel pit, haulage of aggregates was eliminated. The hot mix, after its 3-mile trip, was laid at an average temperature of 275 deg. F.

HOT ASPHALTIC GRAVEL *(left)* **is spread and raked to uniform 3-in. thickness and then compacted by rolling to 2½ in.**



PORTABLE MIXING PLANT ***(above and at left)***, **located at gravel pit, involves no haulage of raw aggregates, which are delivered from bank by belt conveyor. Plant units, on wheels, are cribbed up to reduce depth of truck runway.**

FAST PRODUCTION *and* LEAN MIXES *Cut Cost of Concrete Pavement*

COST of concrete pavement, like that of any manufactured product, can be reduced in either of two ways—by increasing efficiency of production or by using cheaper raw materials. Sheboygan County, Wis., under the direction of George W. Langley, Jr., county engineer, acting with the advice and assistance of the state highway department, has made an outstanding attempt to lower the cost of concrete pavement by utilizing both these means. The U. S. Bureau of Public Roads has cooperated in the effort by making accurate daily tests and keeping a complete record of the results obtained. These records provide a reliable means of ascertaining batch content and uniformity, concrete strength, cost, and operating efficiency under the procedure adopted by Sheboygan County.

Faster production has been attained by increasing the size of the batch for a 27-E paving mixer to 33 cu.ft. and by reducing the mixing period to 50 sec. It has been demonstrated, both in Sheboygan County and in other parts of the country, that batches up to 35 cu.ft. in size can be mixed in a 27-E paver on grades up to 6 per cent without detriment to the quality of the concrete. Tests also have shown that a 50-sec. mixing period will produce the maximum batch uniformly obtainable with the type of concrete distributing bucket now in use on all standard paving mixers.

A more debatable aspect of Sheboygan County's economy program is the reduction in the material cost of the concrete through selective grading of coarse aggregate and use of asmaller cement content. It is hardly necessary to say that application of this principle requires the highest type of engineering design and supervision. Its success on Sheboygan County roads has been marked, but similar results cannot be expected elsewhere unless satisfactory aggregate supplies and equal engineering skill are available.

20-Mi. Paving Job—An example of the efficiency possible under Sheboygan County specifications is the 20-mi. state-aid project of 9—6½—9-in. concrete slab 20 ft. wide built during the past summer by the Morris Martin Construction Co., of Berlin, Wis. The project extended in a general southwest-northeast direction from the Washington County line to a connection with existing pavement a few miles outside of Sheboygan Falls. Most of the project consisted of improved alignment close to old location, but some new location was included. As the road traverses rolling country, much of the pavement was laid on grades and superelevated.

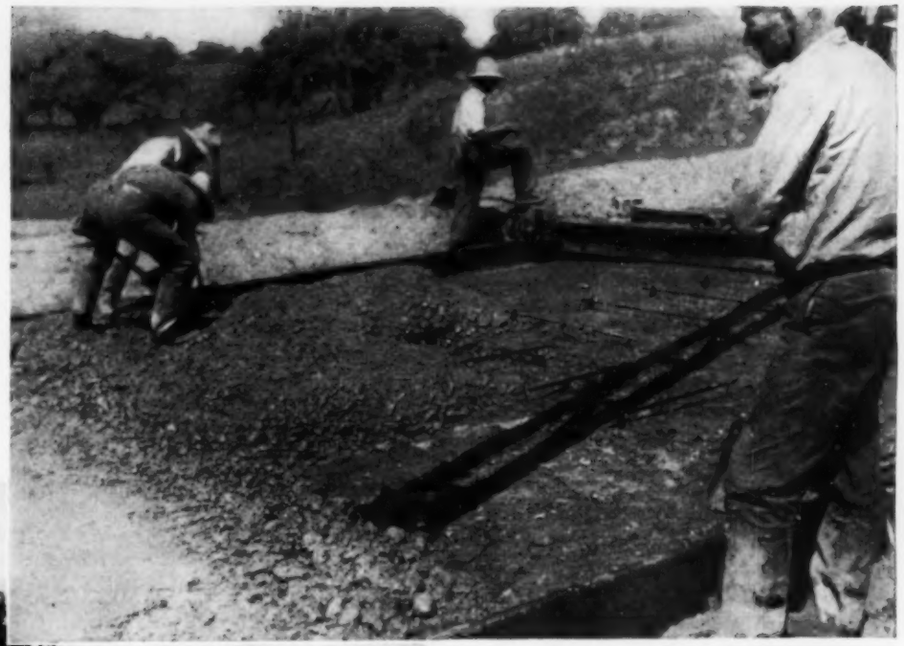
Using a batch size of 33 cu.ft. and a mixing period of 50 sec., the 27-E paver had a maximum capacity of 56 batches, or 162 lin.ft. of pavement, an hour. The contractor equipped and organized the job to maintain close to the maximum rate of production. In an average working week of 60 hr., with good weather conditions, the outfit laid 1½ mi. of pavement. During one 60-hr. week, the mixer poured 8,407 lin.ft. of slab, operating at an efficiency of 88.8 per cent. Paving

FOUR SIZES of aggregate are produced and separated by plant equipped with drag scraper, crushing and screening apparatus, and system of belt conveyors. Single crane handles four sizes to stock piles and to two bins.

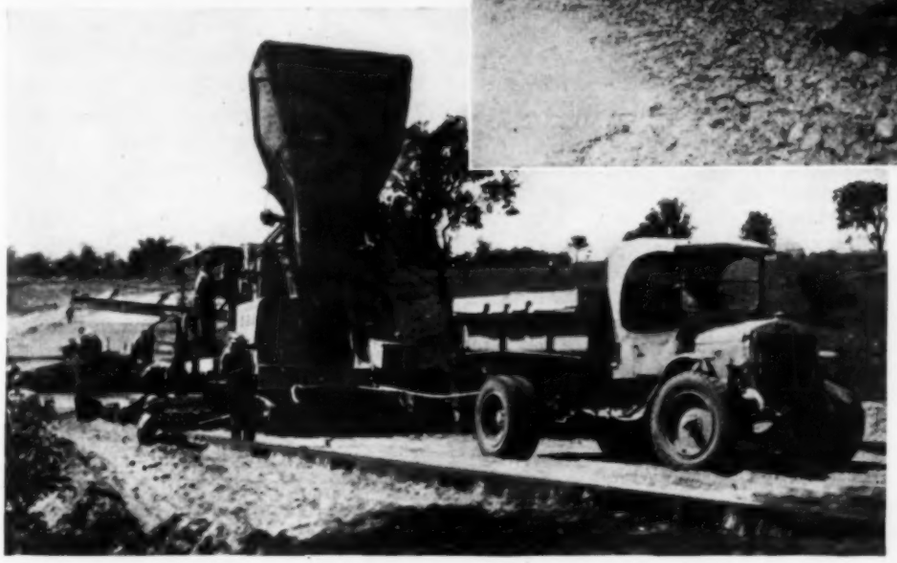
LAYOUT OF PLANT requires trucks to back under each of two bins, delaying loading operation and making extra trucks necessary.

started on June 10 and ended 4 months later, on October 12.

Batch Design—Sheboygan County obtains greater batch-to-batch uniformity and a denser, stronger concrete with lower cement content by using three grades of coarse aggregate. By combining three sizes of coarse aggregate, it is possible to design a mixture with a lower proportion of voids, requiring less mortar and correspondingly less cement. Workability is gained by adjusting the proportions of coarse aggregate and sand, without increasing the water content. The batches coming through the mixer on the Morris Martin Construction Co. job were exceptionally uniform, no dry batches occurring to delay the finishing, as might be expected where lean-mix concrete is being used.



BATCH-TO-BATCH UNIFORMITY is obtained by using three sizes of coarse aggregate. Dowel bars are closely spaced through all joints.

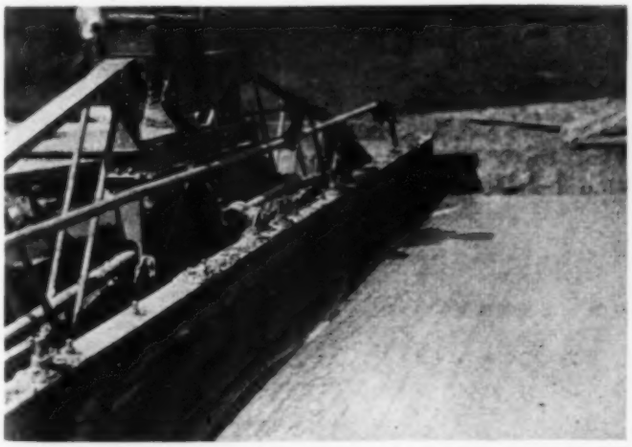


27-E PAVER *(below)* has productive capacity of 56 33-cu.ft. batches an hour under Sheboygan County specifications.

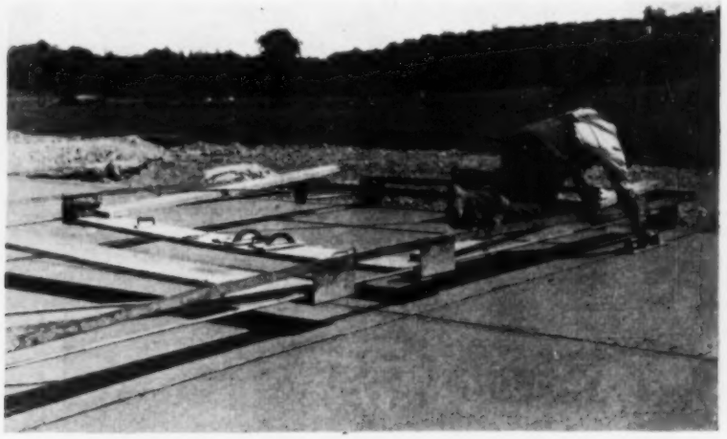
Sheboygan County has found the use of three sizes of coarse aggregate economical, even when the material must be delivered to the job by railroad. Where a job plant of a local commercial plant can haul batches to the mixer, no question exists in the mind of the county engineer as to the economy of specifying three sizes of coarse aggregate. A convenient location for a hillside gravel pit was found near the center of the Morris Martin Construction Co.'s job, as indicated on the plan, and the production of sand and three sizes of coarse aggregate was sublet to a subcontractor.

Aggregate Plant—Specifications required three grades of coarse aggregate in the following sizes and proportions: 2½ in. to 1½ in., 30 to 35 per cent; 1½ to ¾ in., 45 to 50 per cent; and ¾ in. to ¼ in., 15 to 25 per cent. An unusual layout at the aggregate plant enabled the general contractor to handle all four sizes of aggregate with one 1¼-yd. clamshell crane, as shown by the accompanying plan of the plant. A drag scraper brought gravel from the pit and dumped the material through a grizzly on to a belt conveyor which delivered it to the crushing, screening, and washing plant. Four belt conveyors distributed the aggregate from this plant to their respective piles.

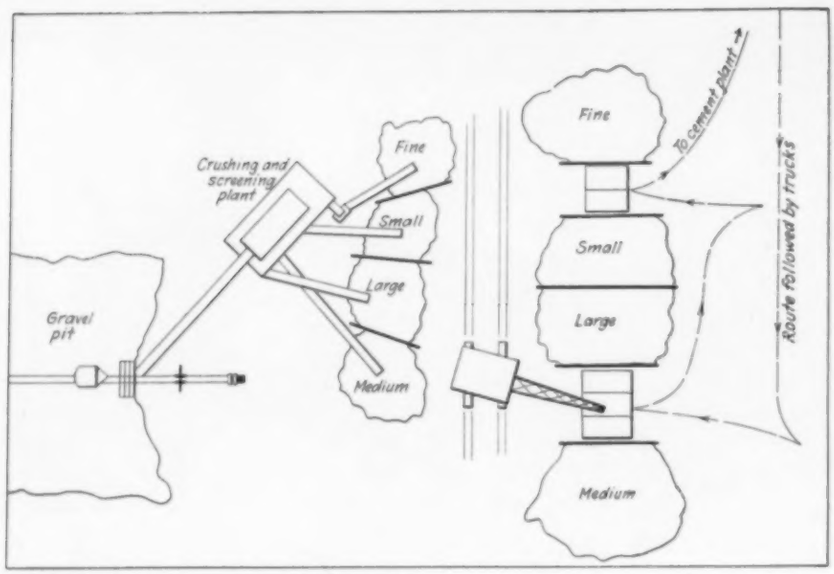
The crawler crane, moving as re-



FINISH MORTAR for dense, smooth surface is uniformly available. Proportioning of sand and gravel provides requisite workability.



TRANSVERSE JOINTS are closely spaced, contraction joints 30 ft. apart and 1-in. poured expansion joints every 90 ft. Center-line contraction joint also is used.



AGGREGATE PLANT LAYOUT is designed for handling of four sizes of aggregate by one 1½-yd. crane. Belt conveyors distribute aggregate from screening plant. Loading of trucks is slowed down by backing under two bins.

quired over a straight runway between these piles and the bins, handled all four sizes of aggregate to the stock piles and bins. A layout susceptible to servicing by one crane required two bins, each holding two sizes of aggregate, with the bins and storage piles located in a straight line. This layout shortened the arc through which the crane had to swing in handling materials but forced the trucks to follow a tortuous and uneconomical route. The trucks had to back under each bin. It was impossible to route the trucks over a circuit which would have taken them straight through the bins, as the crane runway was too narrow for passing. To have turned the bins for straight-line loading would have required another crane. Although the layout required the addition of two trucks to the hauling fleet to take up the time lost in loading, the contractor figured this expense as being lower than the charges for a second crane.

Bulk cement was bought and delivered to the job by the county, but the responsibility for ordering and maintaining deliveries rested with the contractor. Loads of 55 bbl. were hauled in Sterling trucks of the Diamond Cartage Co., Milwaukee, a distance of 50 mi. from the mill at Manitowoc, Wis. At the job, the trucks end-dumped into a 22-bbl. hopper at the base of a cement-handling plant located near the right-of-way, about ¼ mi. from the gravel plant. A screw conveyor delivered the cement from this hopper to a bucket elevator.

Field Tests—Each morning the engineers of the Bureau of Public Roads took samples of concrete for analysis and made cylinders and beams for strength tests. The samples, weighing approximately 80 lb. each, were 9x16-in. blocks cut by a knife from the slab just before the third trip of the finishing machine.

After weighing the sample in air and under water, the engineers washed out the cement and separated the sand and gravel by washing through screens. By weighing the sand and gravel under water and subtracting the total weight from the weight of the original sample under water, the cement content was obtained. After drying in the sun, the sand and gravel were weighed as a check on the screen analysis and on the moisture content of the sample.

Concrete for the 6x8x42-in. beams was taken from the slab at the same place as the sample. The beams were broken at the middle after 7 days and at each end after 28 days. Concrete for the cylinders was taken from a batch just after it was dumped on the subgrade. The cylinders were tested at the end of 28 days.

Test Results—Data on the concrete analyses and strength tests for 1931 have not yet been released; but results of two jobs built under similar specifications in Sheboygan County in 1930 were reported in a paper presented by T. C. Thee, assistant highway engineer, division of management, Bureau of Public Roads, at the last annual convention of the American Concrete Institute. The paper was published in the June issue of the Journal of the American Concrete Institute, with discussions by A. L. Hambrecht, construction engineer, Wisconsin State Highway Commission, and by Mr. Langley. Only one difference existed in the specifications for the two years. In 1930, the concrete was designed with a minimum of five sacks of cement per cubic yard and a maximum of 6 gal. of water per sack. In 1931 the cement specification was reduced to something less than five sacks per cubic yard, but the water requirement remained the same, 6 gal. net per sack.

Total length of the two 1930 projects was 21 mi. Samples and test specimens were taken from 198 batches.

PREMOLDED MATERIAL is installed in longitudinal and transverse cleft-type contraction joints, 2½ in. deep. Automotive machine forms slots for material.

CENTER BREAK of beams taken from poured slab is made after 7 days and end breaks after 28 days. Cylinders also are made from poured concrete and broken after 28 days.

MORRIS MARTIN *(left)* president, Morris Martin Construction Co., and HARVEY VIETH, in charge of cement deliveries.

L. E. GREEN *(left)*, materials inspector; GEORGE W. LANGLEY, JR., county engineer; R. P. RODGERS, junior highway engineer; A. T. BLECK, assistant division engineer; C. R. STOKES, materials engineer; W. E. PATITZ, division materials engineer; and R. M. UBBELHODE *(kneeling)*, materials inspector.

ADAM MARKOFSKI *(left)*, superintendent, and P. JULIAN, junior highway engineer, Bureau of Public Roads.

Analyses of the samples, made by the engineers of the Bureau of Public Roads, showed a variation in proportions by weight of 3.90 per cent within the batch and of 3.07 per cent from batch to batch on Job 1. On Job 2, the variation within the batch was 4.37 per cent and, from batch to batch, 3.22 per cent.

These analyses indicate that the variation from batch to batch was less than the variation within the batch. As tests have shown that the variation within the batch is unavoidable under present conditions, it would be uneconomical to carry selective grading of coarse aggregate any further for the purpose of reducing the batch-to-batch variation. The analyses also showed that the variation within the batch was no greater with a 33-cu.ft. batch and a 50-sec. mixing period than with smaller batches and longer mixing periods.

Cement content as revealed by the analyses was 5.16 sacks on Job 1 and 5.18 sacks on Job 2; water per sack was, respectively, 5.96 gal. and 5.81 gal. Average cylinder strengths after 28 days were 3,642 lb. per square inch on Job 1 and 3,672 lb. on Job. 2. Average beam strengths for the two jobs, respectively, were: 7 days 598 lb. and 595 lb.; 28 days, end break, 872 lb. and 877 lb.; 28 days, center break, 866 lb. and 868 lb.

Money Saved—According to the statement of Mr. Langley, county engineer, increasing the batch size to 33 cu.ft. and reducing the mixing period to 50 sec. has raised the rate of production 37½ per cent. Using the fair average of $1 a minute for the capital and labor charges on a concrete-paving job, this increased efficiency would mean a saving of over 27 cents to Sheboygan County for every minute that a 27-E paving mixer operates in the construction of its roads.

Actual savings effected by increase in batch size and by decrease in cement content were given by Mr. Langley in his discussion of Mr. Thee's paper. Specifications for 23 miles built in 1930 called for the use of four different batch sizes, 27, 30, 33 and 35 cu.ft., as directed by the engineer in charge. Unit bid prices were received for each batch size. The unit prices averaged 3c. per square yard more for the 27-cu.ft. than for the 30-cu.ft. batch and 2½c. more for the 30-cu.ft. than for the 33- and 35-cu.ft. sizes. Reduction of one sack per cubic yard in cement content lowered the cost of concrete about 33c. per cubic yard, or 6½c. per square yard of pavement.

Administration—In charge of the Morris Martin Construction Co. job were Morris Martin, president, and Adam Markofski, superintendent. Mr. Langley directed the work for the county and state, with the cooperation of the state highway engineers. Under T. Warren Allen, chief, division of management, and Mr. Thee, assistant highway engineer, the tests of the Bureau of Public Roads were directed in the field by R. P. Rodgers, junior highway engineer.

Construction Equipment on the Job

GRADING—John O'Keefe, Subcontractor
1—1¼-yd. Northwest Gasoline Shovel.
1—No. 60 Caterpillar Elevating Grader.
7—60-hp. Caterpillar Tractors.
7—8-yd. Euclid Crawler Dump Wagons.
6—1½-yd. Dump Wagons.
1—Adams 12-ft. Blade Grader.
1—Russell 10-ft. Blade Grader.
1—Small Russell Grader.
1—Russell Scarifier.
1—1½-ton Chevrolet Platform Truck.

FINE GRADE—Morris Martin Construction Co.
1—Russell 12-ft. Blade Grader.
2—Euclid Rotating Scrapers.
1—Lakewood Scarifier.
1—Lakewood Subgrader.
1—60-hp. Caterpillar Tractor.
2—30-hp. Caterpillar Tractors.
1—Carr Form Grader.
1—3-ton Austin Roller.

PAVING—Morris Martin Construction Co.
1—27-E (L930) Rex Paver with 25-ft. Boom.
3,800 lin.ft. Metaform Steel Forms, 8-in. Base.
2—No. 9 C.H.&E. Pumps.
1—No. 11 C.H.&E. Pump.
3—Mi. 3-in. Pipe.
3—Mi. 2-in. Pipe.
1—Lakewood double-screed Finishing Machine.
1—Flexplane Joint Machine.

MATERIAL SUPPLY—Morris Martin Construction Co.
1—Koehring 1¼-yd. Crane.
1—Butler Three-compartment Bin.
1—Blaw-Knox Two-compartment Bin.
1—Butler 450-bbl. Bulk-cement Plant.
5—5-ton Oshkosh Four-wheel-drive Trucks.
9—5-ton Titan Trucks.
1—Freeman Turntable.
Additional trucks hired as needed.

MATERIAL PRODUCTION—Clarence Berg, Subcontractor
1—1½-yd. Sauerman Drag-scraper Bucket.
1—Two-drum Mundy Hoist.
1—120-hp. Waukesha Gasoline Motor.
1—300-W Pioneer Gravel Plant.
1—1½-yd. General Gasoline Shovel.

CURBS, GUTTERS, SIDE DRAINS—Morris Martin Construction Co.
1—Rex 10-S Mixer.
1—Set Fairbanks three-beam Platform Scales.

MISCELLANEOUS—Morris Martin Construction Co.
1—1-yd. Northwest Gasoline Shovel.
2—1½-ton Chevrolet Trucks.
1—1½-ton Ford Truck.

SHOULDERS—Dorr Packard, subcontract from John O'Keefe
2—60-hp. Caterpillar Tractors.
1—30-hp. Caterpillar Tractor.
5—20-hp. Caterpillar Tractors.
1—No. 2 Galion Grader.
1—No. 60 Caterpillar Grader.
1—Super-Special Caterpillar Grader.
6—Euclid Rotary Scrapers.
1—3-ft. Fresno Scraper.

Cold-Mix Bituminous Surfacing
HALF-WIDTH

HALF-WIDTH construction in two 10-ft. strips, with traffic passing through the job, was the method employed by the Binghamton Construction Co. in widening and resurfacing with a cold-mix, machine-spread bituminous top an old concrete road between Oneonta and Cooperstown, N. Y. The new surface consists of a 2-in. base course and a ½-in. top course of Amiesite.

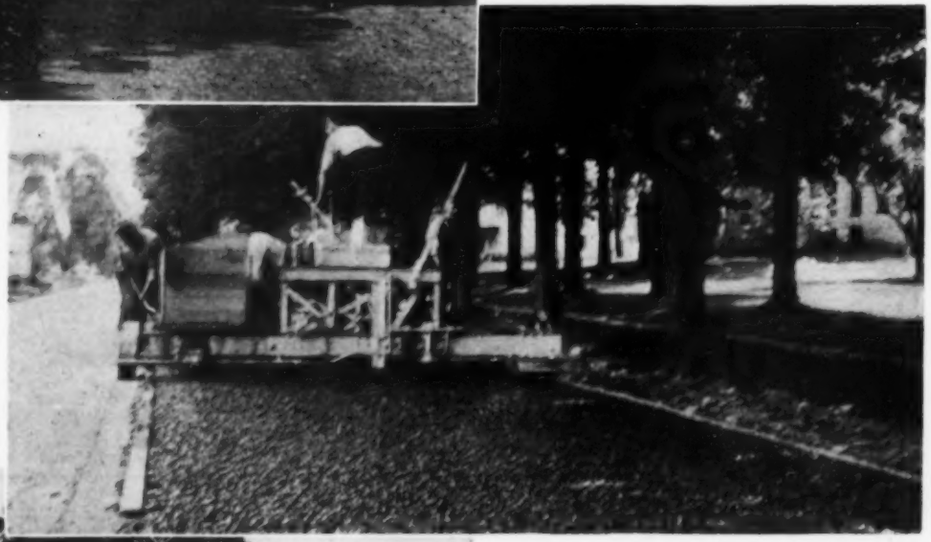
Initial operations consisted of extending the old road to a uniform width of 20 ft. and eliminating irregularities in grade with a preliminary leveling course.

The bituminous resurfacing mixture was hauled to the job from the contractor's plant in Jordanville, N. Y., an average distance of 27 miles. Along the outside edges of the old, widened concrete highway, standard steel forms were set to retain the bituminous mix. Along the center line, however, forms for the half-width work rested on the old concrete surface and were of 2x6-in. hardwood lumber in 10-ft. lengths, capped with a 1x1½-in. steel strip which projected 6 in. beyond the wood at one end to form a lap joint with the adjoining form. To correct for grade irregularities in the old road, it was often necessary to shim up the center forms

FIRST HALF-WIDTH *(above)* receives bituminous surfacing delivered by spreader box (at right) and retained by center-line form of wood capped with steel strip.

METAL STRIP *(below)* along center line prevents screed of finishing machine from gouging completed half of pavement.

FINISHING MACHINE *(above)* has spread new surfacing material and center-line form has been removed.

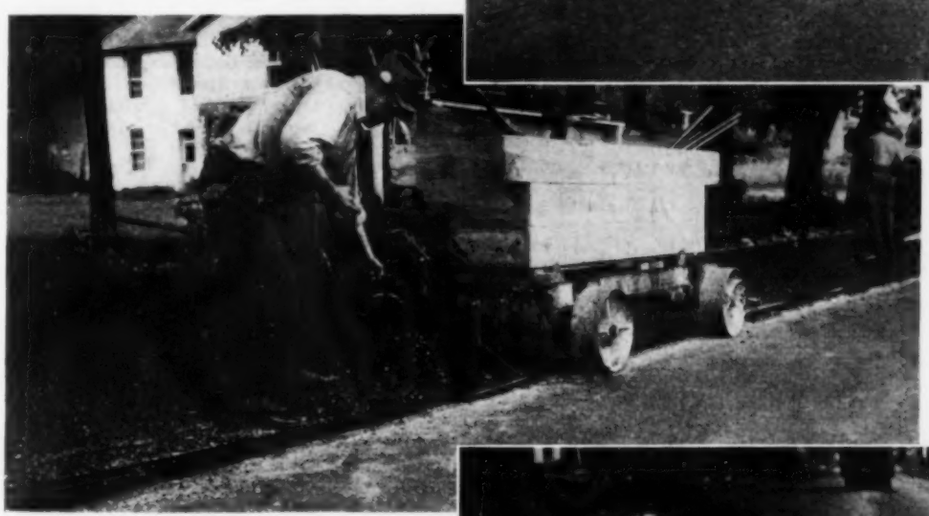


TOP COURSE *(below)* after it has been partially compacted by the roller.

Spread by Finishing Machine on CONSTRUCTION

STRAIGHT-EDGE *(above)*, equipped with level, is used to check surface and set forms.

TRAFFIC *(right)* uses half of the width while the other half is under construction.



SCREED *(left)* of finishing machine rides on steel strip to prevent damage to completed half of surfacing. Note that inner wheels have flat tires instead of flanges.

SEAM *(below)* between completed halves of bituminous resurfacing is ironed out by several passages of the roller.

with wood shingles, using a straight-edge carrying a 2-ft. level to insure accurate setting.

For spreading the cold-mix bituminous material, the contractor employed a Lakewood finishing machine mounted on double-flanged wheels to prevent shifting of the center form. When the old road surface deviated considerably from grade, ten 10-ft. sections of center form were used so that setting and leveling could take place far enough ahead of the finishing machine to prevent delays in spreading. At other times three or four 10-ft. sections of form were set. When the finishing machine had passed over a section of form, the 10-ft. length was removed and carried forward for use again.

After one-half of the road had been resurfaced, flat, instead of flanged, wheels were used on the inner side of the finishing machine to allow it to ride on the edge of the newly completed bituminous surface. A longitudinal steel strip also was placed to prevent the screed of the machine from gouging the surface of the completed half of the road. After the material had been spread by the finishing machine, it was compacted by a gasoline roller which ironed out the center seam between the two halves of the surfacing.

Road Surfaced by Retread-
EMULSIFIED

SPREADING *(left)* ¼- to 1½-in. limestone at rate of 80 to 130 lb. per yard. Locking device on tail gate of truck insures uniform rate of spreading.

BITUMINOUS materials are used extensively by the West Virginia State Road Commission for surfacing on all classes of roads. One of the latest developments in that state in applying bituminous materials was worked out last season on 16½ miles of 18-ft. surfacing on a section of important main highway between Charleston and Beckley.

LEVELING *(above)* base course of stone prior to treatment with emulsified asphalt. Thorough work prevented waves in final surface. **APPLYING** *(left)* 0.4 to 0.5 gal. of retarded-setting emulsified asphalt per yard on stone base. **MIXING** *(below)* base stone and emulsified asphalt. Two trips generally sufficient.

This project is in a mountainous section through which a satisfactory location had been graded some years ago. In 1928-29 this grade was surfaced with a soft local sandstone, which was all that was available. During an exceptional drought in the summer of 1930, a large increase in traffic caused the base to ravel. To improve conditions a surface treatment was undertaken that summer, but the base prevented a good job being done.

The commission could not afford to lay a high-type pavement on this road. Based on good results from some trials made the previous year, it was decided to put a combination retread-penetration surface on this section, using two grades of emulsified asphalt. In the 1930 trials with this type of material, standard retread specifications were used. After having been in service nearly a year this experimental stretch was in good condition and needed no surface treatment, but it was believed that better construction could be obtained at no additional cost by the combined retread-penetration specifications. The latter insured proper interlocking of the aggregates and two seal coats.

The first step was to sweep the old surface thoroughly with a rotary broom. Wherever necessary, care was used to clean out by hand dead material that the broom would not reach.

Omission of the prime coat commonly used in retread work was possible, since the low viscosity of the emulsified asphalt allowed sufficient binder to reach the old base to obtain a good bond. As soon as the old surface was cleaned ahead about a day's

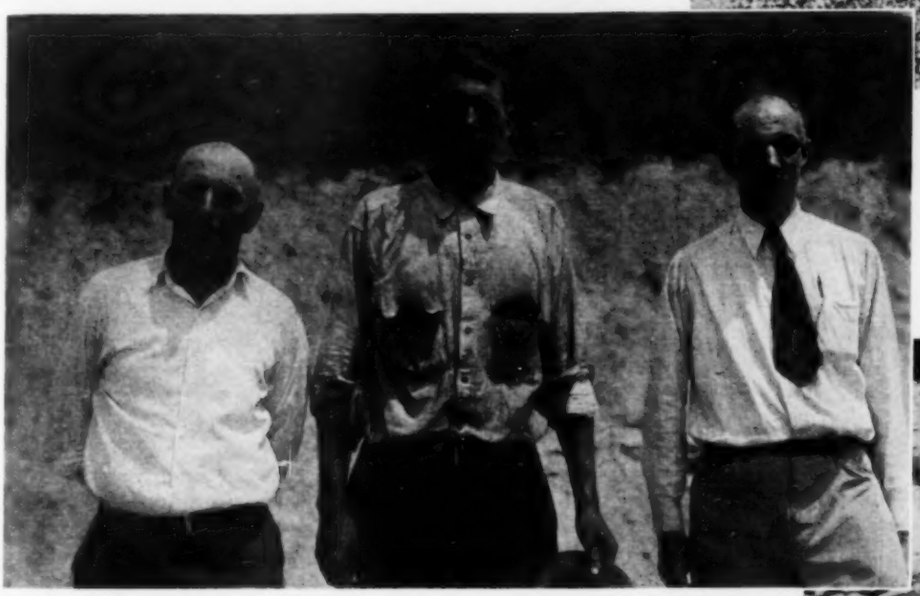
Penetration Method With

ASPHALT

DRAG levels mixed base course of stone and asphalt. Weight and size of drag eliminate waves in final surface.

run, the base course of the retread was placed. This consisted of 80 to 130 lb. of ½ to 1½-in. crushed limestone to the square yard.

Variation in the amount of crushed stone depended on the condition of the old surface. The pot holes in the lat-



(Left to right), E. M. SPANGLER, state inspector; W. P. BLANKENSHIP, superintendent for R. F. Kirkham, contractor, and JOHN P. WEST, resident engineer, state road commission. KEYSTONE *(below)* spread at the rate of 20 to 25 lb. per yard. Controlled adjustable opening of tail gate gives accurate distribution.

ter were filled before the new work was added. But in order to get a true, smooth finished surface that would be free from waves, excess base stone had to be used on much of the 16½ miles. At times when the stone was placed somewhat ahead of the application of the binder, it was windrowed to center with a blade machine drawn by a

Caterpillar tractor. This prevented traffic from wasting the stone, and also avoided having the edges of the pieces of stone rounded off.

With the blade machine and tractor, the base stone was shaped up and accurately leveled just ahead of the application of the binder coat of emulsified asphalt. A grade of asphalt emulsion, having its setting time sufficiently retarded to permit it to be well worked into the stone, was applied cold by a motor truck distributor at the rate of 0.4 to 0.5 gal. per square yard, depending on the amount of stone used.

As soon as the distributor had finished on a stretch, the base course of

CLOSE-UP of drag used, without rear wheels, showing transverse members.

stone and the binder were mixed by a two-section disk harrow drawn by the tractor. Two trips generally gave thorough mixing. Then the coated base-course stone was leveled off with a heavy timber drag which the state highway commission has developed and specifies for this class of work.

This drag is 16 ft. long and 9 ft. wide, with three transverse members shod with steel blades set at an angle of about 30 deg. to the center line. At the rear is a fourth blade almost

BROOM DRAG distributes keystone and chips uniformly and fills minor depressions. Men in truck cover any black spots that show up.

at right angles to the center line of the road. The three sloping blades leave a space at one end so they move loose material along them to that end and pass it back to the next blade. The fourth blade goes clear across the drag and can be set accurately to the crown of the road.

With this drag it was possible to smooth out all dips in the new surfacing such as the very irregular old stone base would cause. In most cases one trip of the drag was enough to get results.

Following the smoothing of the base course with the heavy drag, a 10-ton roller was used to get good compaction. Then, as soon as possible, a layer of ¼- to ¾-in. stone was distributed over the base course at the rate of 20 to 25 lb. to the square yard by trucks running in reverse. This stone application, called the keystone course, was rolled lightly as soon as placed.

On the following day this keystone layer was broom-dragged and well rolled. Then an application of from 0.4 to 0.5 gal. per square yard of quick-setting emulsified asphalt was made. On this was spread, as soon as possible, 15 lb. to the square yard of clean limestone chips ranging from No. 8 to ½-in. screen sizes. This coat of chips was rolled lightly as fast as placed.

After a 24-hr. interval the chips were broom-dragged and rolled well. Then a second application of penetration-grade was added at the rate of 0.4 gal. to the square yard. Directly following this, 12 lb. of the same size chips as just mentioned were spread to the square yard and immediately rolled lightly. As the final step the surface was broom-dragged and well rolled the next day.

All operations were handled without diverting traffic from the road. Due to the sequence of operations and the character of the binders, very little trouble resulted from picking up by cars using the newly surfaced road.

With the limestone delivered in place at $2.80 per ton for all sizes, and with labor at 30 cents per hour, R. F. Kirkham, of Charleston, W. Va., as contractor on the job, received on the average 34½ cents per square yard.

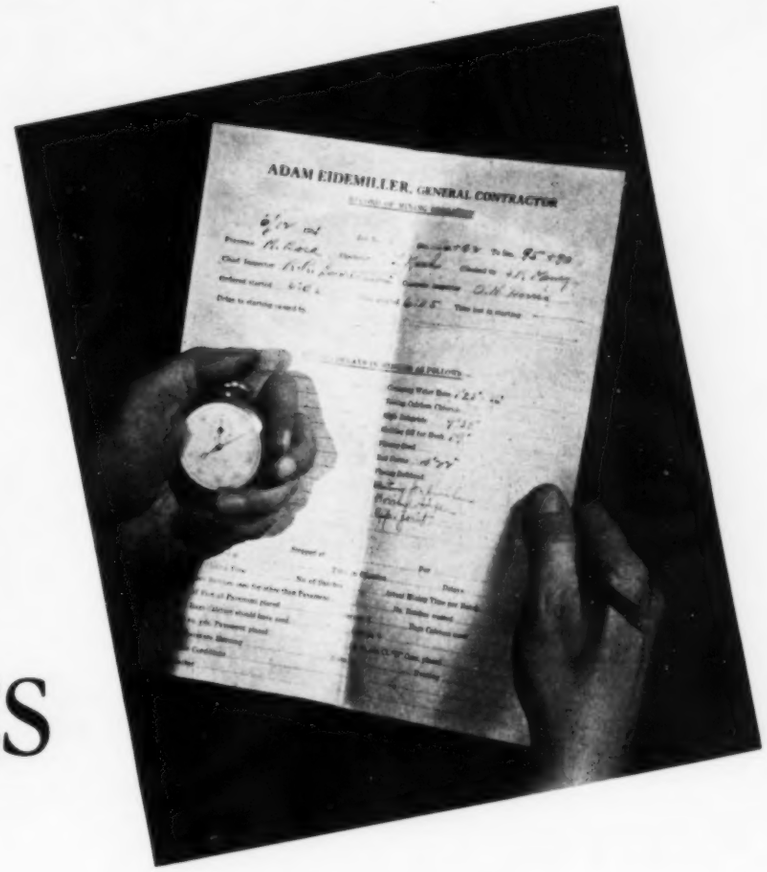
The resulting surface is remarkably uniform and free from waves. At the same time, it lacks any surplus binder in the surface and the grading of the stone with the two seal coats give a tight job that averages about 1¼ in. thick. The American Bitumuls Co. furnished the emulsified asphalts used.

Col. C. P. Fortney, as chairman and chief engineer of the West Virginia State Highway Commission, followed this project closely from the beginning, with E. G. Middleton as assistant chief engineer in charge and G. H. Davis district engineer. E. L. Worthington is construction engineer for the district, and J. P. West was resident engineer on the job.

FIRST APPLICATION of quick-setting emulsified asphalt at rate of 0.4 to 0.5 gal. per yard. No trouble from fat streaks along the center line where applications overlap.

CLOSE-UP of broom drag used on keystone course after light rolling.

STOP-WATCH STUDIES



Reduce Concrete-Paving Delays

IT is commonly acknowledged that the profit or loss on a concrete-paving job depends ultimately on the productive efficiency of mixer operation. On a 5.35-mi. length of 20-ft. 9-7-9-in. slab which he laid last summer on the Lincoln highway east of Greensburg, Pa., for J. C. Ciccone & C. J. Centrone, of Philadelphia, general contractors, Adam Eidemiller, of New Alexandria, Pa., paving subcontractor, made a systematic effort to discover and eliminate the small delays which reduce concrete production. Tangible gains in the form of greater production and steadier operation resulted from the study given to mixer delays.

ADAM EIDEMILLER *(right)*, paving contractor, and MICHAEL BLOCK *(left)*, mixer foreman.

A Two-Mixer Job—The Pennsylvania department of highways designed the new 5.35-mi. section to eliminate or reduce a number of heavy grades and sharp curves. Most of the paving, 50,000 sq.yd., was on relocated right-of-way, where the full 20-ft. width could be laid. A large part of the work, however, consisted of reconstruction on old location under traffic. This reconstruction involved 13,000 yd. of pavement which had to be placed and cured in half widths of 10 ft. each. To speed completion of the job, Mr. Eidemiller assigned a 1-yd. paving mixer to each of the two types of construction.

General Construction Plant—On the full-width pavement, the contractor used a 1931 Multi-Foote paver, and, on the half-width construction, a 1928 model of the same machine. One material-handling depot, equipped with a $\frac{3}{4}$-yd. Erie steam crane, supplied both paving mixers. When concreting operations were not too widely separated, one Barnes triplex pump provided water for mixing and curing at both pavers, by pumping in two directions through 2-in. pipe.

Recording Mixer Delays—A time checker equipped with a stop watch was stationed at the mixer on full-width construction to keep an accurate record of the cause and duration of every delay. A printed form facilitated the recording of the causes of delays. One of the illustrations reproduces this form.

From a study of the report turned in by the checker each day, the contractor could instantly put his finger on the causes of lost time in production. With this information at his com-

STEAM CRANE with ¾-yd. clamshell bucket charges 70-ton bins with sand and crushed rock, keeping two paving mixers supplied with material.

mand, he was able to reform the procedure where necessary, thus forestalling a recurrence of delays from the same causes.

Results of Time Study — Mr. Eidemiller's system of checking mixer delays was largely responsible for maintaining operations at an average efficiency of 88 per cent. In 215 hours, 50 min. of actual working time, the mixer operated 194 hours, 49 min. and laid 32,684 sq.yd. of concrete. With a job average of 1.4 per cent for overrun, this yardage required 7,600 batches.

An efficiency of 40 batches an hour was established empirically as the maximum attainable under the most favorable conditions. In one day of 11 hours, 54 min. mixing time, and 12 hours, 15 min. working time, the production amounted to 479 batches, or 40 batches per hour of mixing time. Accepting this rate of production as 100 per cent efficiency, the paver would be capable of mixing 7,800 batches in 194 hours, 49 min. and 8,620 batches in 215 hr. 50 min. Letting these figures represent 100 per cent efficiency for the mixer and for the job, we find that the paver actually operated at 97.4 per cent and the job at 88.0 per cent efficiency.

Daily Records — On an ordinary working day, the mixers ran continuously from 6 in the morning until 4:30 in the afternoon. The best record made by the two units on one day consisted of 1,020 ft. of 20-ft. pavement and 1,022 ft. of half-width slab, requiring a total of 790 batches. This record was made on a day of 13 hr. 33 min., 10 sec. actual mixing time and 13 hr., 45 min. working time. A total delay of 11 min., 50 sec, was caused by trucks and subgrade.

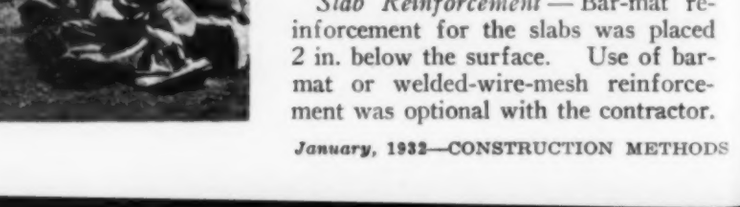
Training Time Checkers—In the opinion of Mr. Eidemiller, the salary and traning cost for a time checker are considerably less than the amount saved through use of the time studies. An intelligent young man with a serious desire to learn the concrete-paving business makes a good time checker. After a few days' supervision by the contractor's superintendent or chief engineer, a time checker may be depended upon to keep a record which approaches 100 per cent accuracy. Suggestions by the superintendent and engineer will help to improve the checker's discrimination and accuracy as the job progresses.

Mixing Cycle—Pennsylvania highway specifications require a mixing period of 1 min. 15 sec. after all materials have been admitted to the drum. Adding 12 to 15 sec. for hoisting the skip and discharging the drum, the total mixing cycle becomes approximately 1½ min. Greater speed of the 1931 Multi-Foote paver in lifting the skip reduced its mixing cycle 3 sec. below that of the 1928 machine used on half-width paving.

Fine Grading and Forms—An overrun of only 1.4 per cent for the job was obtained by exercising great care in finishing the fine grade and setting and resetting the forms. The general contractors had performed all the rough grading during the preceding winter and spring. A Lakewood subgrader was used on the fine grade of the full-width paving section. On the half-width section, final subgrade trimming was performed by hand. Scratch templets were used on both widths to check the final grades.

Blaw-Knox steel forms were carefully checked for grade and alignment,, after the passage of the subgrader. The form setters tamped earth under each joint solidly to prevent settlement under the weight of the finishing machine. Operation of the two paving units required a total of 6,000 ft. of 9-in. forms and 1,600 ft. of 7-in. forms. Both heights of forms had a base width of 6 in.

Slab Reinforcement — Bar-mat reinforcement for the slabs was placed 2 in. below the surface. Use of bar-mat or welded-wire-mesh reinforcement was optional with the contractor.



SEPARATE COMPARTMENTS *(right)* for bulk cement, as required by Pennsylvania specifications, are obtained by paying premium of 5c. per batch to trucking contractor. QUICK-SETTING CEMENT *(below)*, for half-width paving on sections under traffic, is transported in paper sacks which are opened as truck approaches mixer.

To prepare the first layer of concrete for the bar-mat, a strike-off riding on the forms was pulled forward by two cables attached to a power winch on the mixer. This mechanical strike-off, shown in operation in one of the photographs, reduced the time and labor needed to level the first layer of concrete. Reinforcing bars, joint material and a machine to install the joints were supplied under an unusual contract by the American Steel & Wire Co.

An automotive Flexplane machine

MECHANICAL STRIKEOFF *(above)*, operated by power winch on mixer, levels concrete to receive bar mat 2 in. below surface of slab. MANUALLY OPERATED STRIKEOFF *(left)*, levels concrete for bar mats on half-width pavement. A. D. MORGAN, contractor's engineer, directs operation.

installed the cleft-type, center-line joint. Joint strips 2¼ in. deep by ¼ in. thick by 5 ft. long were hooked together with wire clips and were fed into the center-line slot in a continuous ribbon. An expansion joint containing premolded Carey asphalt material ½ in. thick was placed at every break in the grade, an average distance of 200 ft. apart. The two 10-ft. strips of half-width pavement were tied together with ⅝-in. dowel bars 5 ft. long, spaced 5 ft. apart and 18 in. from each expansion joint.

Material-Handling Plant—The batching plant was located on a railroad spur which crossed the road about ½ mile east of the center of the job. An Erie steam crane, equipped with a Blaw-Knox ¾-yd. clamshell bucket, handled all the sand and rock from gondola cars into the Johnson 70-ton bins, which discharged into hoppers for weight measurement. Reserve supplies of sand and rock were stored in stock piles. In order to place the stock piles and bins within the operating radius of the crane, it was necessary to turn the bins against the railroad embankment in such a way that the trucks had to back under the weighing hoppers to receive a load, instead of driving straight through, as would have been the desirable arrangement under different conditions. The crane unloaded as many as 17 cars, approximately 900 tons, of material in one day, working overtime, as usual.

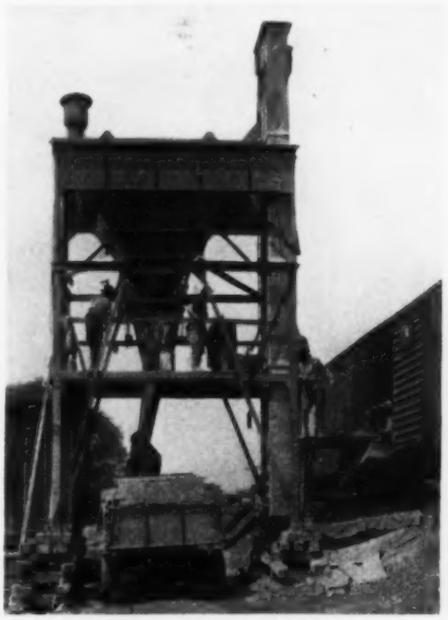
Cement for the full-width paving was handled by a Blaw-Knox bulk-cement plant with a bin capacity of 120 bbl. As usual with the Blaw-Knox plants, the cement was unloaded from box cars by a drag scraper and was dumped into a hopper which fed a bucket elevator through a screw conveyor. The elevator dumped the cement into the overhead bin, from which the cement was drawn off and weighed before being discharged through a canvas spout into containers on the trucks.

Batch Hauling—A subcontract for batch hauling was given to a trucking contractor who stayed on the job to supervise his trucks and drivers. Payment was made on the basis of the number of batches hauled. A premium of 5c. per batch was paid to have the trucks equipped with separate cement containers. Each of the trucks hauled three batches, except one which had a capacity of two batches. The longest haul, 3 miles, to the west end, required eleven trucks.

Proportions of the concrete mix were 1:2.2:3.5. Each batch included 6 bags of cement (564 lb.), 1,236 lb. of sand and 1,890 lb. of crushed hard blue limestone.

Half-Width Paving—A batch of the same proportions, with Incor quick-setting cement substituted for ordinary portland cement, was used on the half-width paving to permit early opening of the slab to traffic. Test beams were broken at various periods up to 72 hours. As soon as a modulus of rupture of 550 lb. per square inch was obtained, the engineers opened the pavement. In hot weather, the concrete often gained the necessary strength in 24 hrs.

Administration — Under Samuel Eckels, chief engineer of the Pennsylvania department of highways, and H. E. Kloss, district engineer, Pittsburgh, the work was directed by R. E. Mackey, assistant engineer, and R. R. Garrettson, senior inspector. Assisting Mr. Eidemiller in the management of the job were A. D. Morgan, engineer, and Michael Block, mixer foreman.



BULK-CEMENT PLANT unloads, elevates, stores and weighs cement.

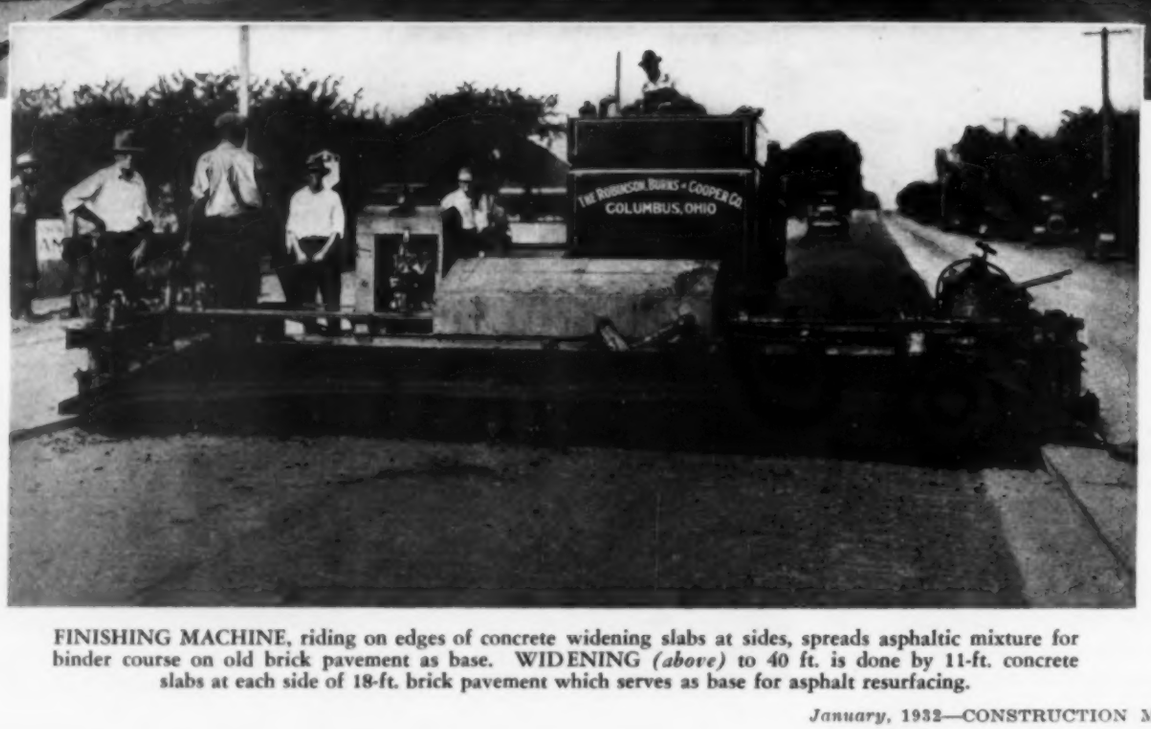
Brick Pavement Resurfaced With
MACHINE-SPREAD ASPHALT

REHABILITATION of 3.7 miles of U. S. Route No. 50, an old 18-ft. wide brick pavement on concrete base at North Kingsville, Ashtabula County, Ohio, was accomplished by widening to 40 ft. with 11-ft. concrete slabs on each side and resurfacing the brick with a 2¾-in. asphalt top spread by a finishing machine. The job involved 37,404 sq.yd. of asphalt resurfacing mixed and placed by the Robinson, Burns & Cooper Co., paving contractor of Columbus, Ohio.

The new asphalt surface consists of a 2-in. binder course and a ¾-in. top course produced by an 1,800-lb. Cummer portable plant operated by the contractor. The equipment included a four-compartment bin and a jacketed screen to get separation of sand and three sizes of stone. For the base course, the stone ranged in size from ¼ to 1¼ in., and for the top course from ¼ to ½ in. It required approximately 1 ton of top surface mixture to cover 4 tons of base course. On the average the plant produced 259 tons per day, the largest day's run being 364 tons.

The crew at the asphalt plant consisted of 12 men as follows: 1 foreman, 1 crane operator, 1 boiler fireman, 1 oiler, 1 mixer man, 1 scale man, 1 chain feeder, 2 men cleaning cars, 2 men on material and 1 clerk. Haulage from the plant to the job was done by the contractor's own trucks, four 2½-ton Autocars.

Both the binder and the top courses were spread by an Ord Blaw-Knox finishing machine. No side forms were required as the asphaltic material was retained by the sides of the two concrete widening slabs, upon the edges of which steel angle iron strips served



FINISHING MACHINE, riding on edges of concrete widening slabs at sides, spreads asphaltic mixture for binder course on old brick pavement as base. WIDENING *(above)* to 40 ft. is done by 11-ft. concrete slabs at each side of 18-ft. brick pavement which serves as base for asphalt resurfacing.

METAL STRIP *(above, left)* protects edges of concrete widening slabs from wheels of finishing machine and gives excess thickness of asphalt to allow for compaction by rolling.

JOINT between new asphalt surfacing and concrete slab at side is sealed after finishing machine has passed and metal protecting strip been removed.

BEFORE ROLLING, showing texture of asphalt and smooth, uniform surface produced by mechanical spreading.

WIDENED TO 40 FT. Central strip, 18 ft. wide, is old brick pavement with asphaltic resurfacing. At each side new 11-ft. concrete slabs extend width.

the dual purpose of protecting the concrete from the wheels of the finishing machine and giving an excess depth of asphalt to compensate for compaction by subsequent rolling. The contractor's procedure was to place, spread and roll the binder for about 100 lin. ft. (200 sq.yd.) and then move the finishing machine back to spread the top course. The thickness of the binder course had to be varied somewhat to compensate for irregularities in the grade of the existing old brick-paved surface, which served as a base for the asphalt pavement. For the resurfacing operations, the top gang consisted of 1 foreman 1 finishing machine operator, 2 roller men, 2 rail men, 1 raker, 4 shovelers and 2 flagmen.

The work was done under the direction of the state highway department of Ohio, H. P. Chapman, chief engineer, C. E. Wild, division engineer and E. F. Clark, resident engineer. H. G. Cooper was in charge for the Robinson, Burns & Cooper Co. Lewis & Copeland, contractors, built the concrete strips.

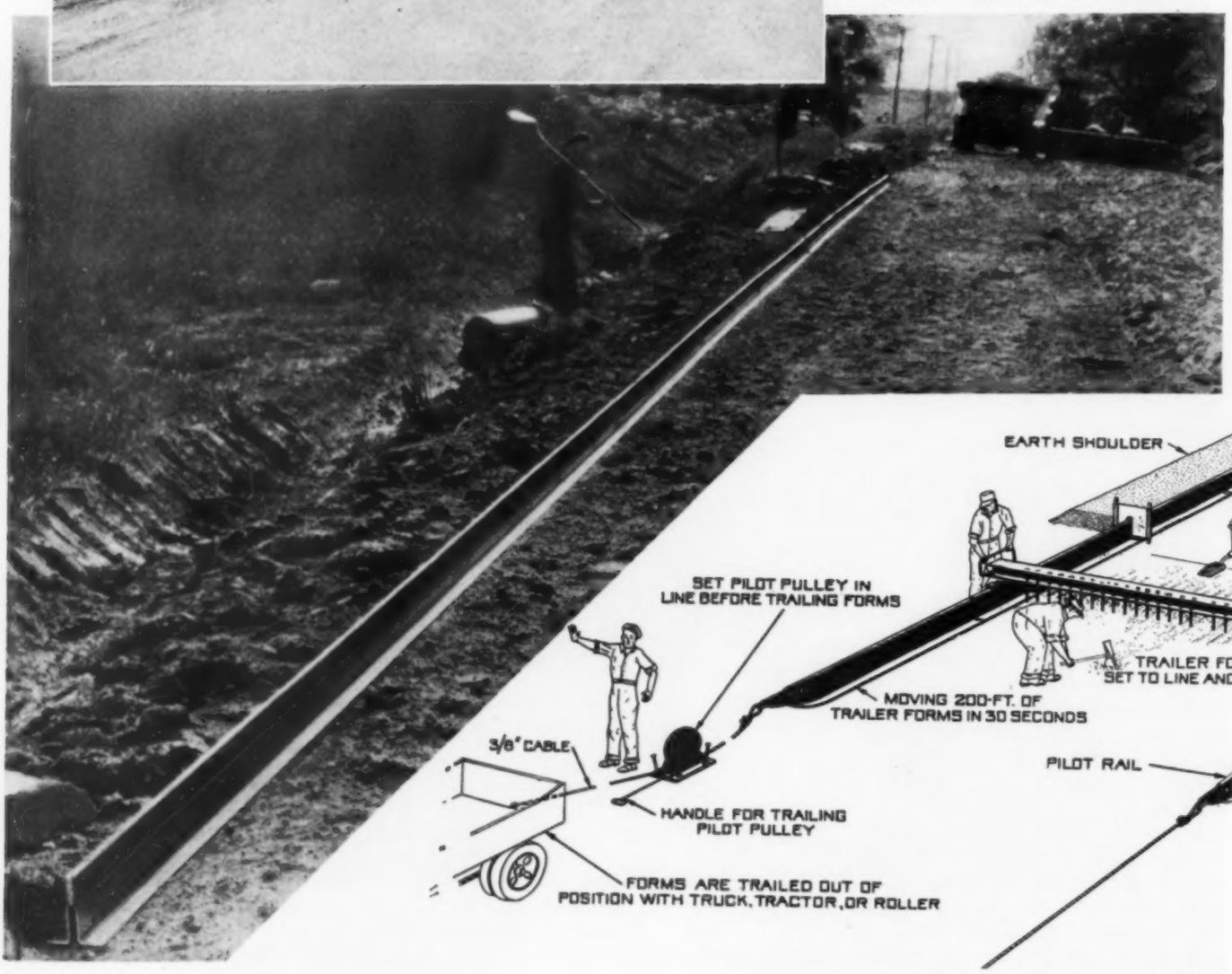
Macadam Roads Built With STEEL TRAILER

WITH the object of introducing into the construction of roads of the low-cost type, refinements in method and improvements in equipment comparable to those which have been developed in building the more costly types of concrete or bituminous paved surfaces, Trumbull County, Ohio, this year, awarded a contract for plain macadam to be built with the aid of a new kind of trailing steel side forms. Under the supervision of Ralph G. Taylor, county engineer, the McDermott Construction Co., of Niles, Ohio, insured an orderly, systematic procedure on the job by scheduling a definite sequence for the several operations involved. The accompanying sketch indicates the relationship among these field operations.

The main departure from ordinary practice in macadam construction is found in the retention of the crushed stone at the sides by the use of the trailing steel forms, a product of the Heltzel Steel Form & Iron Co. These forms are built in 10-ft. sections which are connected by means of a coupling wedge, inserted from the bottom, to form a train 200 ft. long at each side of the subgrade. The construction procedure is as follows:

After the forms have been set to line and grade, the road base is graded

TRAILING OF FORMS *(left)* is done by cable from motor truck which passes under pilot pulley staked in line with forms, producing horizontal pull. TRAIN *(below)* of forms consists of 10-ft. lengths connected to produce 200-ft. section.

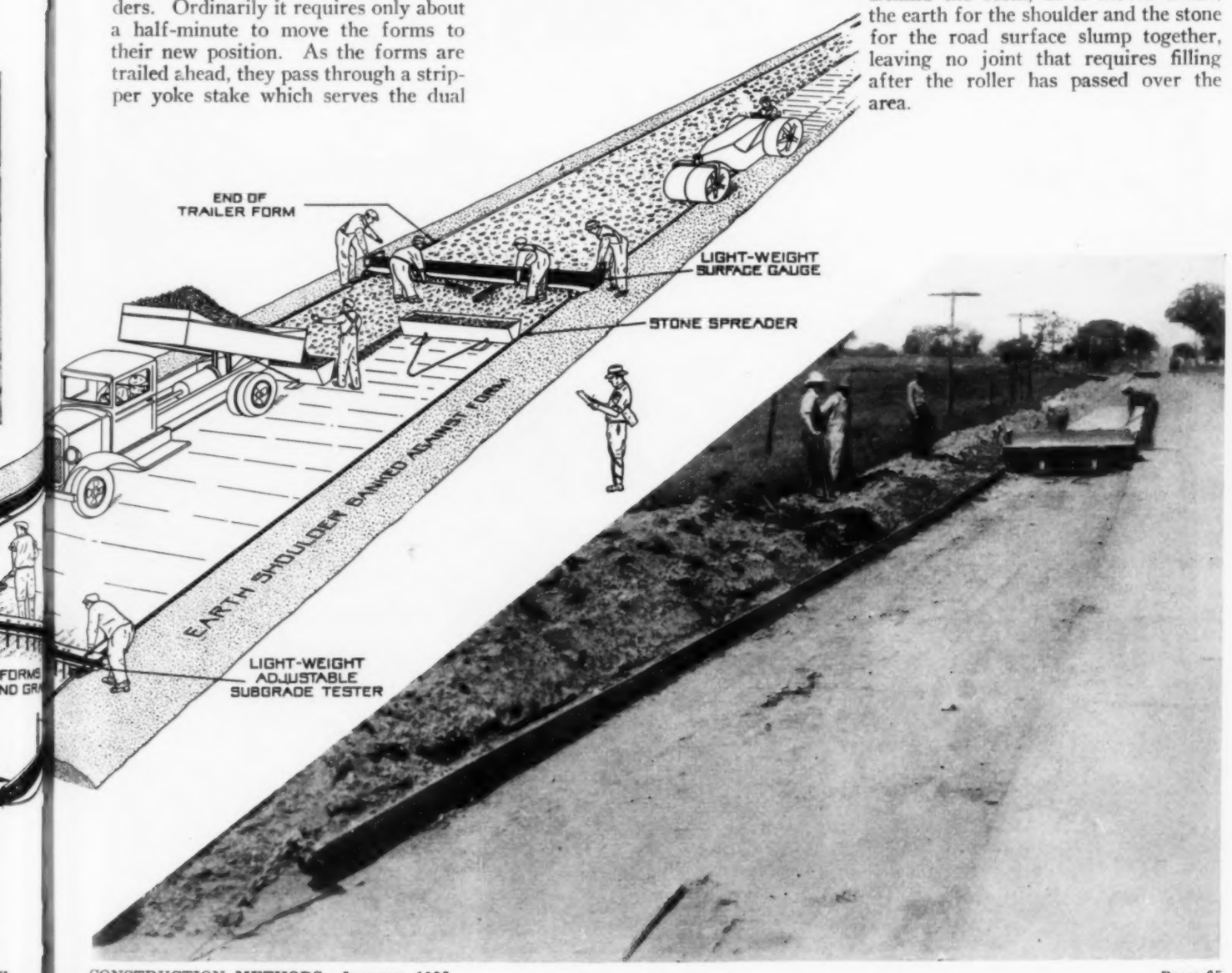

EARTH SHOULDER
SET PILOT PULLEY IN LINE BEFORE TRAILING FORMS
TRAILER FORMS SET TO LINE AND GR
MOVING 200-FT. OF TRAILER FORMS IN 30 SECONDS
3/8" CABLE
PILOT RAIL
HANDLE FOR TRAILING PILOT PULLEY
FORMS ARE TRAILED OUT OF POSITION WITH TRUCK, TRACTOR, OR ROLLER

Aid of FORMS

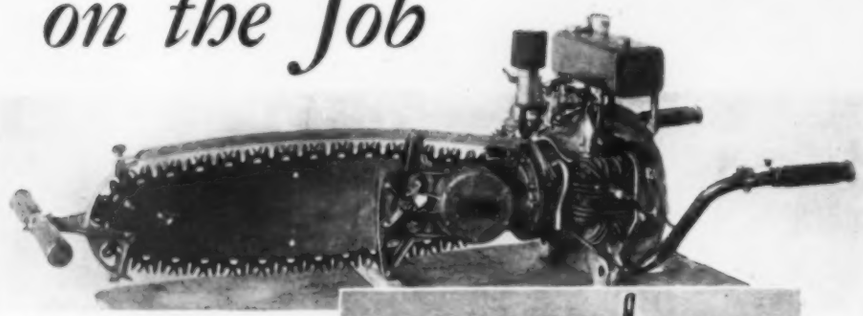
and checked with a light subgrade template. Earth for the shoulders is deposited against the outside of the forms and stone is deposited between the forms by a stone spreader attached to the rear end of the truck. Riding on the forms, a light surface gage, hand operated, levels off the stone.

When a sufficient length of stone has been placed on the subgrade, each 200-ft. length of steel forms is pulled ahead by cables from a motor truck. As illustrated, the cable passes under a pilot pulley securely staked on the line of the forms so as to produce a direct horizontal pull without uplifting the end of the train of forms. After the forms have been trailed ahead about 150 ft., a road roller compacts the stone behind them and consolidates the earth shoulders. Ordinarily it requires only about a half-minute to move the forms to their new position. As the forms are trailed ahead, they pass through a stripper yoke stake which serves the dual purpose of cleaning the forms and preventing dragging of the earth shoulder. Behind the form, as it moves ahead, the earth for the shoulder and the stone for the road surface slump together, leaving no joint that requires filling after the roller has passed over the area.

SPREADER BOX behind motor truck distributes stone uniformly in course of desired thickness.



NEW EQUIPMENT *on the Job*



TWO-CYLINDER, FOUR-CYCLE, AIR-COOLED GASOLINE ENGINE developed for use with Wolf portable timber sawing machine and with pumps, construction machinery and light and power plants. Develops 8 hp. at 3,600 r.p.m. Weight 46 lb.—Reed-Prentice Corp., Worcester, Mass.

WRENCH SET, designed for millwright work, industrial maintenance and construction. Sockets for practically all nuts, bolts and cap screws in use. Wrenches equipped with "Lock-On" drive which prevents sockets from slipping off accidentally. Contains complete selection of handles, extensions, ratchets and speeders. Packed in chest with drop front, removable tray, three pull drawers and fixed tray.—Blackhawk Manufacturing Co., Milwaukee, Wis.

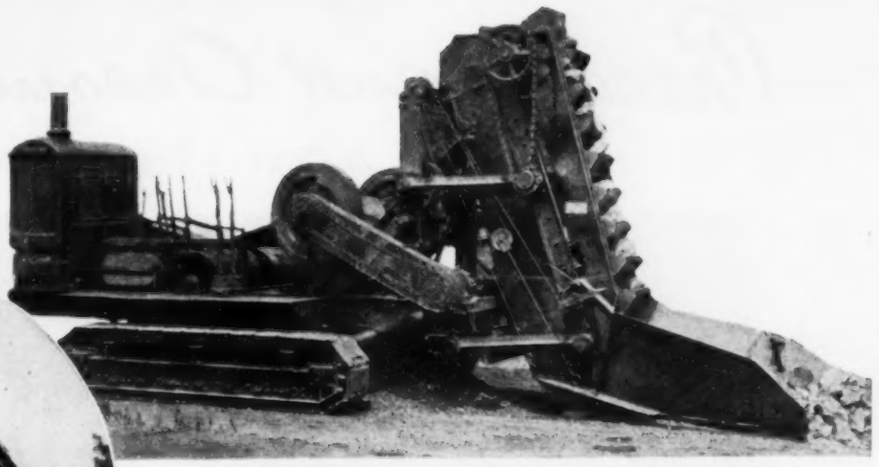
SPONGE RUBBER JOINT provides waterproof filler between sections of concrete pavement and other structural materials. Standard size is ¾x1½ in. by 12 ft. It is black and of 200 per cent porosity. Should be coated with rubber cement and then compressed by hand into the open joint ¼ in. below surface of concrete.—B. F. Goodrich Co., Akron, Ohio.

SHALLOW EXCAVATING GRADER *(below)*, for use particularly in road construction, cuts 0 to 12 in. deep 8 ft. wide in one operation. Sensitive one-man control. Excavating unit, mounted on tractor in front of crawler treads and supported by two heavy side arms which pivot at rear of machine, can be adjusted and tilted to shape of grade. Earth discharges at either side. Capacity, 66 to 300 sq.yd. at 0 to 12-in. depth per hour. Maximum volume capacity, 75 cu.yd. per hour.—Chas. T. Topping Co., 125 Lexington Ave., Aspinwall, Pa.

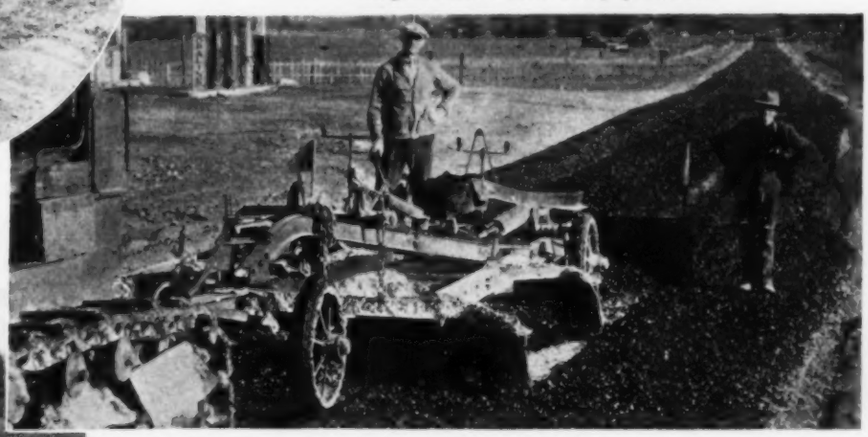
HAMMERHEAD BOOM *(left)*, mounted on crawler crane, erecting steel for highway bridge near Paducah, Ky. Trusses weigh 58,000 lb. and are being handled at 13-ft. radius. Boom provided with sheaves for 5-part line and designed to keep load away from boom structure. —Northwest Engineering Co., 28 East Jackson Blvd., Chicago, Ill.

DUAL-DRIVE MOTOR GRADER *(left)*, equipped with 10-ft. blade and 6-cylinder, 40-hp. motor, for work in soft ground. Driving mechanism permits four drive wheels to hug ground, provides greater traction and freedom from miring and skidding, and insures longer life for tires. Can be equipped with scarifier, snow blade and snow plow. — Austin-Western Road Machinery Co., 400 N. Michigan Ave., Chicago, Ill.

CRAWL TRACTOR-ROAD ROLLER *(below)* for work on rough and broken ground. Each rear crawler unit is free to rotate on its axle and in combination with the gyroscopic-mounted front wheels gives the machine a three-point suspension which compensates for the uneven ground and enables it to cross ditches and climb over hills without pitching or overturning.—Tractor speeds ½ to 2½ m.p.h.—Roller develops 1½ to 5½ m.p.h. — Hercules Co., Marion, Ohio.

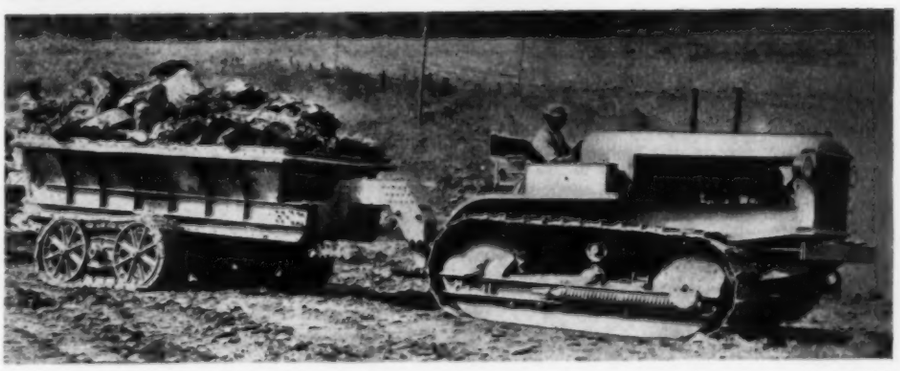


SELF-PROPELLED CRUSHING UNIT, picks up gravel from windrow, elevates, crushes, screens and returns it to road. Crawler type for road construction has a range of from 4½ ft. per minute working speed to 2 mi. an hour road speed. Wheel type for maintenance travels 8 ft. per minute at work and 10 mi. an hour at road speed. —Rogers Iron Works Co., Joplin, Mo.



MIXING AND LEVELING DRAG, designed for mulch and retread work. Supplied with direct tractor hitch, rubber-tired wheels, Timken wheel bearings, and enclosed lift gear cases operating in grease. Weights counterbalanced by springs assure easy operation of controls. Spring-mounted operator's seat. 11-ft. strikeoff has three-piece blade, adjustable for crown, a plumb bob and degree indicator. Automatic edge, 22 ft. long, is built into machine. — Jeffrey Manufacturing Co., Columbus, Ohio.

DITCHER *(above and at right)* for use in laying small pipe lines, gas and water mains, house connections and conduits. Machine, mounted on pneumatic tires, is only 7 ft. 3 in. high and 6 ft. 9 in. wide. It will cut trench 6, 9 or 12 in. wide and 4 ft. 6 in. deep at 20 digging speeds up to 16 ft. per minute. Travels at four different speeds up to 6.4 mi. an hour. Parsons Division, National Equipment Corp., No. 30th St. and W. Concordia Ave., Milwaukee, Wis.



SIX - CYLINDER, TRACK - TYPE TRACTOR has six forward speeds, ranging from 2 to 6½ mi. per hour, force feed lubrication, oil, air and fuel filters and removable cylinder sleeves. Has low center of gravity combined with high road clearance.—Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

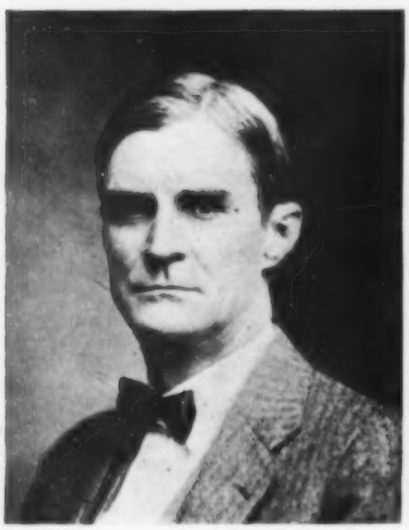
Present and Accounted For —

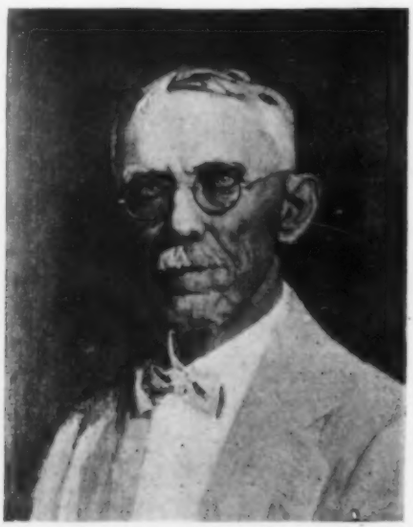
A Page of Personalities

HERBERT S. CROCKER, consulting engineer, of Denver, Colo., nominee for the presidency of the American Society of Civil Engineers, will be inducted into office at the society's annual meeting in New York this month. He was born in New Hampshire, and was graduated from the University of Michigan in 1889. After service with the American Bridge Co. from 1901 to 1906, he opened a consulting office in Denver. During the World War he was in charge of the construction of the Army Supply Base in Brooklyn, N. Y., with rank of lieuetnant-colonel, Engineers.

T. H. CUTLER, chief engineer of the State Highway Commission of Missouri, is the nominee for president of the American Road Builders' Association. His election will be confirmed at the Association's annual convention in Detroit this month. Mr. Cutler entered the department in 1923 as assistant division engineer, served overseas during the World War, and engaged in municipal drainage and highway work as manager of his own company. He is completing a term as director of the American Road Builders' Association.

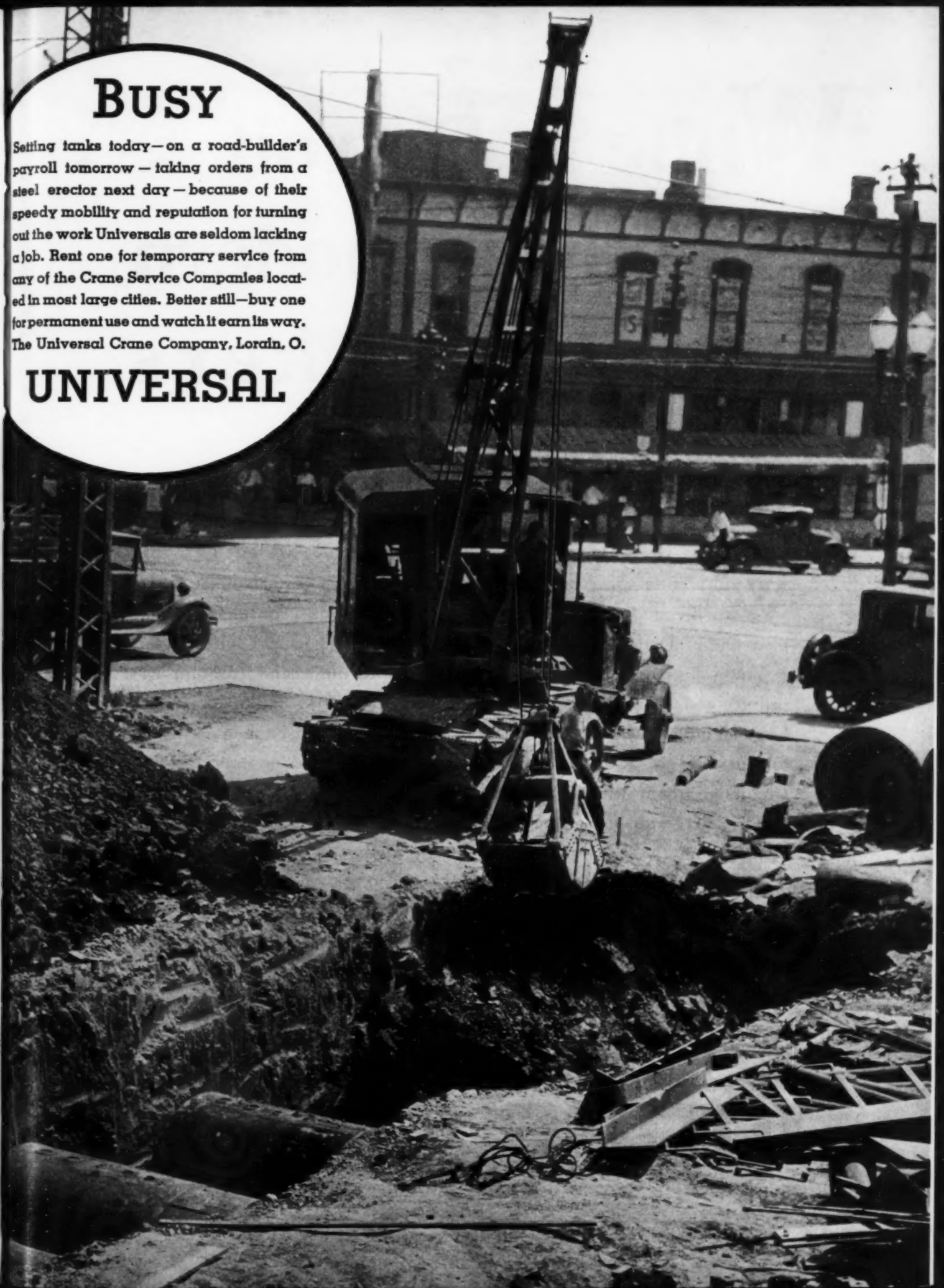
GEORGE F. BLACKIE, who joined the engineering department of the Nashville, Chattanooga & St. Louis Railway as a rodman in 1886, has been appointed chief engineer to fill the vacancy created by the resignation of Hunter McDonald.





HUNTER McDONALD has retired as chief engineer of the Nashville, Chattanooga & St. Louis Railway after 52 years of continuous service with the road of which he was chief engineer for 39 years. Mr. McDonald is a past-president of the American Society of Civil Engineers.

JOHN RUSSELL, JR., has been elected general chairman of the Construction Section of the National Safety Council. He is associated with United Engineers & Constructors, Inc., of Newark, N. J., and has taken an active part in accident prevention work.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to fit any job

Economy rules on the construction job of today. And what better mark of economy is there than operating equipment that fits the job.

In selecting your portable air compressor, the size required is of first importance. From the eight SCHRAMM sizes, you can select a compressor that will operate the smallest spray gun to the biggest tools of the construction industry. Every size includes the same SCHRAMM construction features and can be mounted in any style for any portable use.

Convince yourself that there is a SCHRAMM *for any job*—at greater economy than any other compressor. Write for the catalog describing the complete SCHRAMM line.

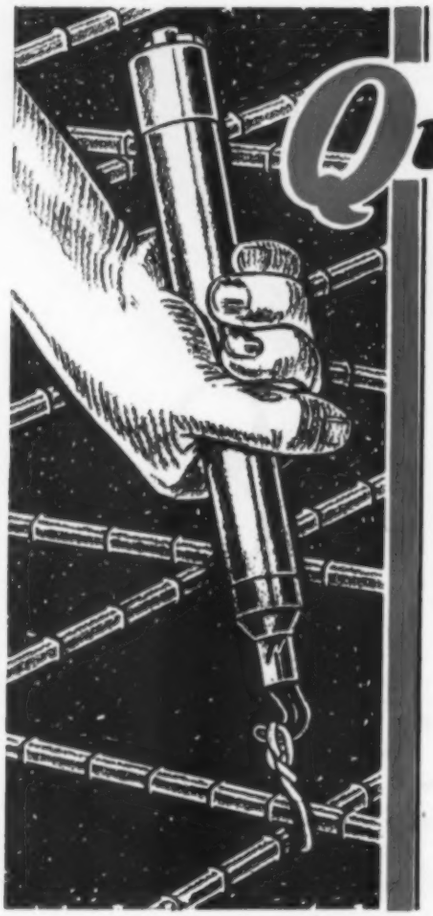
SCHRAMM AIR COMPRESSORS

BRANCHES:

New York	Tulsa
Philadelphia	San Francisco
Pittsburgh	Los Angeles
Chicago	Birmingham

Schramm Inc.

WEST CHESTER, PENNA. · · · · REPRESENTATIVES IN ALL IMPORTANT CITIES



Quicker, stronger - Bar Ties

IT is surprising how quickly ties may be made with Bates Wire Bar Ties. Simply apply tie, hook Bates Tying Tool into looped bands—*and either pull or twist* according to gauge of wire used. The tie is instantly made—and it is a strong tie, too. • Even chilled, clumsy fingers—even unskilled laborers—work remarkably fast with Bates Wire Bar Ties—and the speeding-up helps greatly to reduce costs. • Try Bates Wire Ties on your next culvert, bridge or other re-inforced concrete work. A sufficient quantity for a fair trial will be sent free—and we will gladly lend you a couple of Bates Tying Tools.

BATES VALVE BAG CORPORATION
Division of St. Regis Paper Company
60 East 42nd Street, New York, N. Y.

BATES
WIRE BAR TIES

8,000 c.p. for 12 hours

with the

National Carbide X-100
V-G LIGHT

or 16,000 c.p. for 6 hours with use of extension

National Carbide V-G Light X 100

plus one 7-lb. charge of National 14-ND carbide and 7 gallons of water. One man easily handles this V-G Light. Nothing to get out of order. Not easily tipped over; weight is 75% on bottom; but if knocked over, there is no danger and light continues operating when righted. Weight only 33 lbs. empty; 96 lbs. full. This V-G Light has been specified on recent Westchester County Sanitary Sewer Commission jobs. All V-G Lights mean

V-G, Handy Light—Y100

Portable Daylight—Without Waste

No waste of carbide, whether used intermittently or continuously. They have proved their safety, economy and efficiency.

Write for Booklet "Lights" on complete line of V-G Lights, V-G Handy Light and V-G Lantern. A Light or Lantern for every purpose.

National Carbide Lantern WLI-CI

Send for Illustrated Booklet "Lights"

NATIONAL CARBIDE SALES CORP.
Lincoln Bldg., New York

Specify National Carbide in the Red Drum — Coast to Coast Distribution

WHY YOU SAVE MONEY WITH LAY-SET

HAZARD WIRE ROPE COMPANY
Wilkes-Barre, Pennsylvania

Send me by return mail your booklet entitled, "12 Reasons Why You Save Money With Lay-Set Preformed Wire Rope." C. M.—1-32

Name.....

Address.....

Company.....

(Write on margin type of service)

MAIL TODAY

Internal stress in ordinary (non-preformed) wire rope literally eats up your money. Ordinary wire rope is like a bundle of springs—114 of them in a 6 x 19 wire rope. Each one of these 114 wires is held in place by force—resulting in a tremendous internal stress.

No wonder a firm seizing is necessary to confine this stress. No wonder the individual wires break prematurely from fatigue.

Now consider Lay-Set Preformed Wire Rope. Strands and wires lie normally in position. Wires and strands are free to do an equal share of their work. They wear down to a feather edge before breaking. There is no premature breaking of individual wires due to fatigue.

30% to 300% increased service is the result.

EVERY WIRE ROPE USER SHOULD READ THIS BOOK

There are 12 leading reasons why you save money with Lay-Set Preformed Wire Rope . . . 12 easily understood facts about Lay-Set that you should know before you order another foot of wire rope.

This is the beginning of a new year. Scan your wire rope bills of 1931. Figure how much 30% to 300% increased wire rope service means to you in dollars and cents . . . plus the saving in fewer recabling jobs. Now is the time to plan for better wire rope efficiency.

Send for our new booklet, "12 Reasons Why You Save Money With Lay-Set Preformed Wire Rope." It explains in a non-technical manner, why the elimination of internal stress results in 30% to 300% increased service, depending upon the type of your equipment and nature of the wire rope service.

Attached to the booklet, you will receive a sample length of Lay-Set Preformed Wire Rope—so you can . . .

MAKE THIS TEST

Unwind a strand as shown in the illustration to the right. Note the perfect helical shape to which the strand and wires in the strands are set.

Then reverse the strand end for end and put it back into the rope. You won't be able to tell which strand was removed.

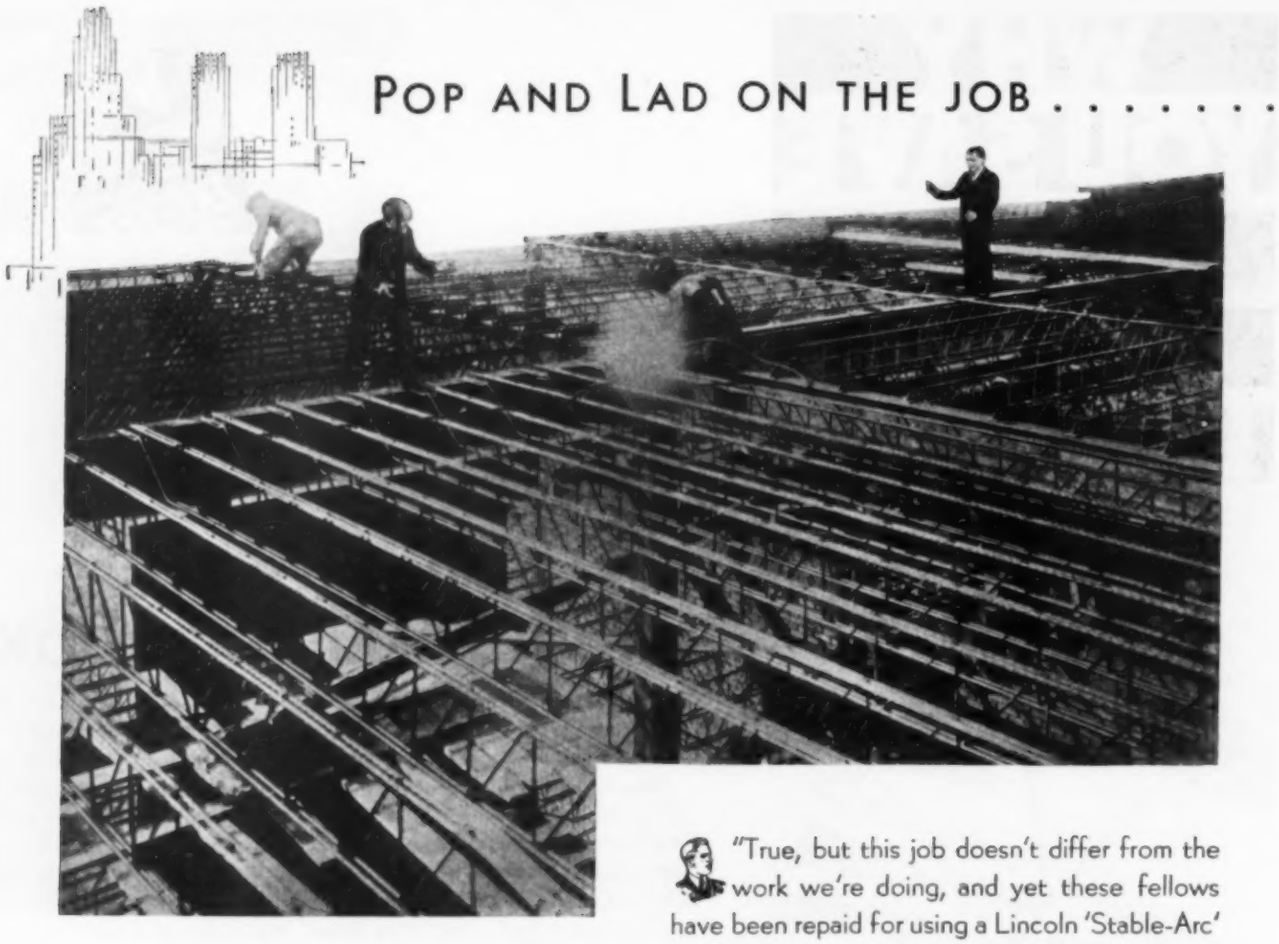
The coupon at the top of this page is for your convenience—mail it to us today for your copy of "12 Reasons Why You Save Money With Lay-Set Preformed Wire Rope." If you prefer, write us in full. Tell us the type of your equipment. Our engineering staff is at your service to help you save wire rope money. Write or wire today.

REDUCE YOUR WIRE ROPE EXPENSE BY 10% TO 70%

Established in 1846

HAZARD LAY-SET PREFORMED WIRE ROPE

POP AND LAD ON THE JOB . . . . . .



"I've been studying Lincoln's data on some of those jobs that their welding machines worked on in Pittsburgh, Baltimore, Fitchburg, Cleveland and no end of cities where arc-welded buildings were put up.

"I see future business for arc welding—but I don't see enough work on the boards right now to justify any welding specifications. What work we have right now is for riveted construction only."

"True, but this job doesn't differ from the work we're doing, and yet these fellows have been repaid for using a Lincoln 'Stable-Arc' welder to weld the bar joists in place for keeps.

"You know, we've always said to clip them over the flange of the beam. Then when planks were laid and the rumble of wheelbarrow traffic jiggled along, the bar joist kicked loose, sometimes turned over, and we've had accidents from this cause. These fellows have the right idea to save all this by arc welding the bar joists to the supporting member.

"They're actually adding strength and rigidity to the structure—doing what arc welding always does—bettering the job—and buttering more parsnips."

LINCOLN

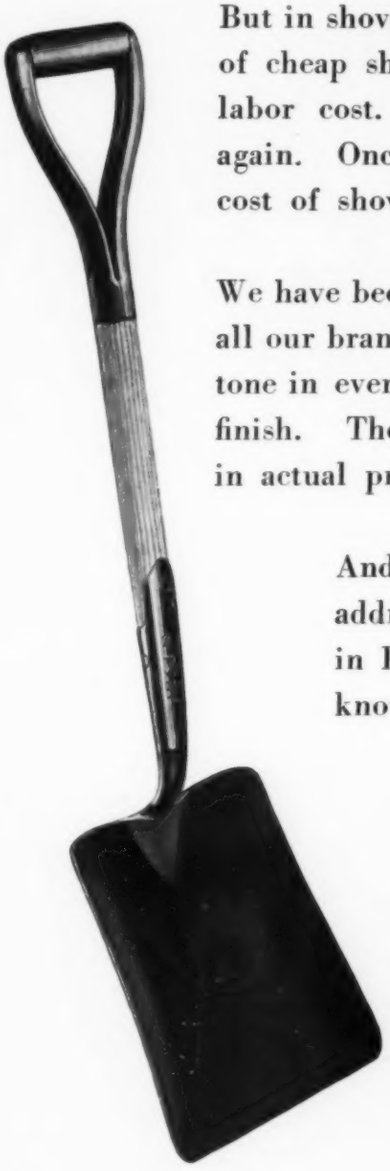
THE LINCOLN ELECTRIC COMPANY, CLEVELAND, OHIO

Largest Manufacturers of Arc Welding Equipment in the World

W-2

The dip is not deep nor long

IT is manufacturing history that when general conditions dip into depression, buying tends to dip below quality. Tight buying easily becomes cheap buying.



But in shovel buying the dip is not deep nor long. The inefficiency of cheap shovels quickly shows a glaring *extra* expense for *extra* labor cost. So, cheap buying promptly becomes careful buying again. Once more we say: "It's not the cost of shovels, it's the cost of shoveling."

We have been hammering away to stabilize standards of excellence in all our brands. And we think you have already seen the improved tone in every grade. Certainly there has been a fine development in finish. The benefits of these activities are now becoming apparent in actual practice.

And while we are on the subject of progress, we have a new address—Parkersburg, W. Va. We have centralized our offices in Parkersburg to give us a central point of action, and we know it will be very much to the advantage of all concerned.

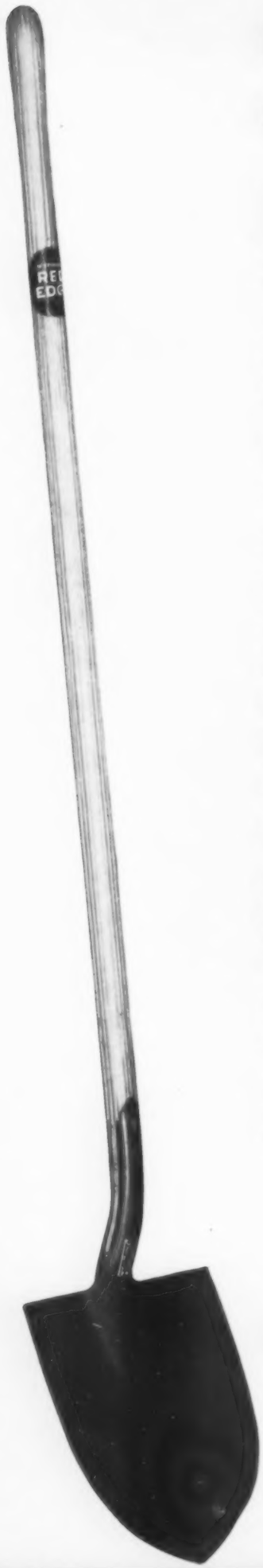
ABW

WYOMING RED EDGE SHOVELS AND PICKS

Manufactured and Warranted BY OLIVER AMES AND SONS NORTH EASTON, Mass. U.S.A. REG. U.S. PAT. OFF.

BALDWIN'S MONONGAH FEATHERWEIGHT BALDWIN TOOL WORKS PARKERSBURG, W. VA., U.S.A.

PONY



Half-moons come too soon

HALF-MOONS may be romantic in the sky, but on the end of a shovel blade they are business tragedies. At every swing they cut into profits.

And the blade of a shovel is no more important than the handle that goes with it. There are two business ends to a shovel—both must be good. The most intelligent shovel specifications we have ever seen are those that call for two good ends.

It's the labor that swings the shovel that costs the money. So, contractors must turn their attention to careful shovel buying more than ever. How long will the handle work? How soon will the first inch of the blade be gone? Will the edge turn up or half-moon? These are the questions he must ask himself.

Shovel makers, too, must be ready to give assurance on these points. We have Genuine O-Ames, Red Edge, Monongah, Pony and Knox-All ready to satisfy the need for longevity, full size, true blade edge, sturdy handle and that easy swing that comes from perfect balance.

Good dealers everywhere carry ABW Shovels. Look for the mark.

ABW

AMES · BALDWIN · WYOMING SHOVEL CO.

PARKERSBURG, W. VA.

Operating Plants in

ALTON, ILLINOIS · ANDERSON, INDIANA · NORTH EASTON, MASS.
PARKERSBURG, W. VA. · PITTSBURGH, PENNA.

Continuous Winter Concrete Construction with CALCIUM CHLORIDE

YOU can pour concrete without interruption all through the winter months when Calcium Chloride is used. You can reduce the time required for usual cold weather precautionary measures . . . reduce the cost of forms, because they can be released in half the time . . . decrease time lost between different operations because work progresses smoothly . . . get more work per hour from floor finishers . . . all of which means more profit to you.

The use of Calcium Chloride gives denser, stronger concrete. Investigate this efficient way of speeding up your winter jobs. Any of the firms listed below will be glad to send you complete information. Write to one of them today for information about the use of Calcium Chloride in concrete construction.

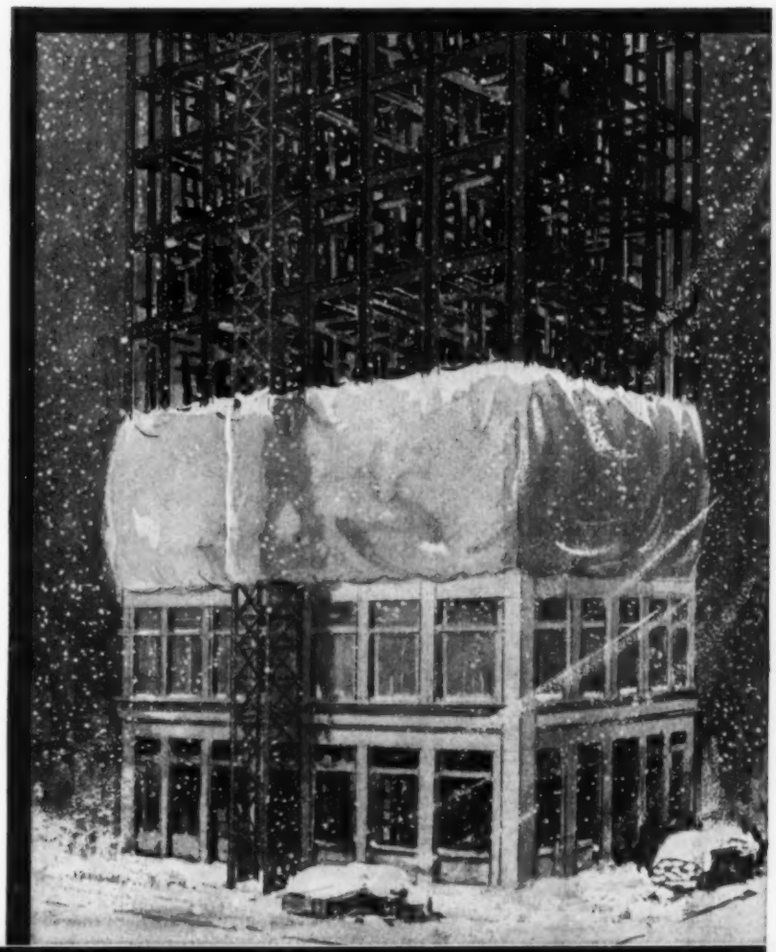
CALCIUM CHLORIDE ASSOCIATION

THE COLUMBIA ALKALI CORP.
Barberton, Ohio

SOLVAY SALES CORPORATION
61 Broadway, New York City

MICHIGAN ALKALI COMPANY
Wyandotte, Michigan

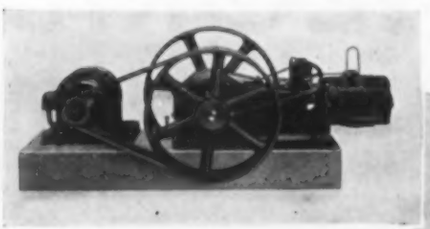
THE DOW CHEMICAL COMPANY
Midland, Michigan



CALCIUM CHLORIDE
FOR SAFE, FAST WINTER CONCRETE CONSTRUCTION

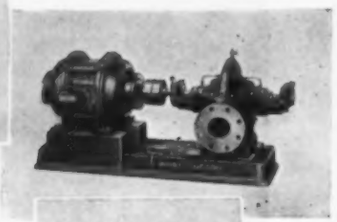
Made

Worthington 330 cu. ft. Air King Portable Air Compressor, "Towabout" type



Worthington Stationary Compressor with Worthington Multi-V-Drive

Worthington Ball-Bearing Centrifugal Pump



Worthington Power Pump

Worthington Vertical Drainage Pump

Worthington Backfill Tamper

Worthington Trench Digger

Worthington Clay Spade

Worthington Pavement Breaker

Worthington Rock Drill

COMPRESSORS

Portable—Gasoline engine, fuel oil engine or electric drive; skid, trailer, motor truck, tractor or rail car mounting

Stationary—Horizontal and vertical; single and duplex; one to four stage; steam, Diesel engine, belt or electric drive; for air, gas or ammonia service

CONTRACTORS AIR TOOLS

Pavement Breakers, Clay Spades, Trench Diggers, Backfill Tampers

ROCK DRILLING EQUIPMENT

Rock Hammers, Drifters, Plug and Feather Drills, Giant Sinkers, Drill Steel, Hose, Accessories, Forging Furnaces, Automatic Heat Treating Machines

MULTI-V-DRIVES

Complete units comprising Goodyear Emerald Cord Belts operating in grooved sheaves

PUMPS

Centrifugal—Horizontal and vertical; single and multiple stage; engine, belt, turbine or electric drive

Steam—Direct-acting and flywheel; horizontal and vertical; simplex and duplex; piston and plunger; simple, compound and triple-expansion; condensing and non-condensing

Power—Horizontal and vertical; single, duplex and triplex; piston and plunger; engine, belt, gear or electric drive

Rotary—Internal or external bearing; belt, turbine or electric drive

Deep Well—Reciprocating type; one, two and three plungers; belt or gear drive—Rotating shaft type; belt, turbine or electric drive.

Sump—Axiflo and centrifugal types

FEEDWATER HEATERS

Open type—for stationary, locomotive and marine services

CONDENSERS AND AUXILIARIES

Surface, Barometric and Jet Condensers; Steam-Air Ejectors, Vacuum Pumps and Special Auxiliaries

METERS

Disc, turbine, compound and piston types; for cold and hot water, gasoline, oil and grease

DIESEL ENGINES

Vertical types for stationary and marine services
Single-acting—two-cycle direct injection, four-cycle air or direct injection
Double-acting—two-cycle air injection

GAS ENGINES

Horizontal double-acting type—for power and gas compressor services
Vertical single-acting type for power service

CHROMIUM PLATING

Complete facilities for heavy plating of machinery parts for salvage and for protection against wear, erosion, corrosion and high temperatures

Literature on Request

WORTH

for the Men
who build our Roads

330 cu. ft. Worthington Air Compressor mounted on highway trailer. Used on a large Pennsylvania highway job by Charles F. Puff, Contractor.

. . . a comprehensive line of Contractors Equipment

Contractors who build the highways of the nation realize the advantages of being able to obtain three of their major needs from *one* reliable manufacturer...Worthington.

Portable air compressors, rock drills and other air tools, and pumps of all types, now can be bought from this one source, thus fixing responsibility and saving time. When the contractor deals with Worthington, he gets service from a manufacturer who sees to it that each of his problems is given individual attention.

The Worthington *Air King* Portable Air Compressor, the acquisition that has rounded out the line, is built in sizes for every purpose, from 110 cu. ft. to 330 cu. ft. capacity. With the famous Feather Valve Compressor, the Continental Red Seal Gasoline Engine, and the unconditionally-guaranteed electrically-welded frame, the *Air King* combines features found in no other portable air compressor.

Only in Worthington Rock Drills is the rotation mechanism independent of the hammering. These drills are "free-hammering." Pavement breakers . . . trench diggers . . . clay spades . . . backfill tampers . . . are included in the line of Worthington Air Tools.

Worthington Pumps have been used for more than three-quarters of a century. Whether the need is for a centrifugal, power, deep well or steam pump, Worthington has one *that will exactly fill the needs* of the individual contractor.

In addition to manufacturing a comprehensive line of equipment, Worthington places at the disposal of the contractor the services of its large staff of engineers. To consult these engineers about your problems incurs no obligation. *Just telephone or write to the nearest district office.*

WORTHINGTON PUMP AND MACHINERY CORPORATION

Works: Harrison, N. J. Cincinnati, Ohio Buffalo, N. Y. Holyoke, Mass.

Executive Offices: 2 Park Avenue, New York, N.Y.

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HNGTON G-121

Worthington Pump and Machinery Corporation, Harrison, N. J.
You may send me information on the following Worthington products:
Name
Position
Company
Address

B

For Road Maintenance or "WARCO" Construction Knows no Equal

SEE OUR EXHIBIT AT THE
DETROIT ROAD SHOW
JAN. 11-15,
SPACE 214, SECTION F

WARCO
BUCYRUS
OHIO

WARCO One-Man "Road Hog" power graders are engineered—not just assembled.

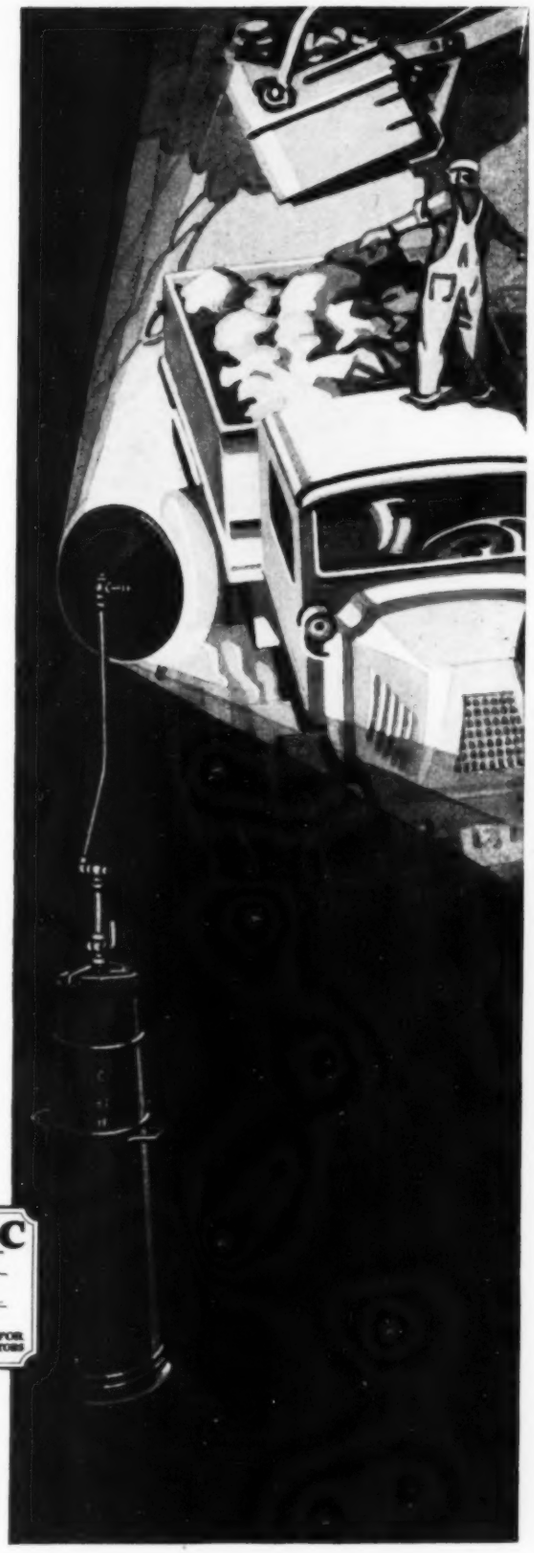
They are expected to do construction work, in keeping with their size (and you have three sizes for selection), as well as high-class, fast maintenance.

WARCO oscillating rear-type crawlers, or new OCTOPUS Pneumatic-tired Traction Unit hitch the power of your tractor to the ground.

If you want to trim shoulders, cut down banks, do ditch work, scarify, grade and level, patrol, maintain or remove snow, there is a WARCO Power Grader for the job. We have them in three sizes and six models—either center or rear control—with solid or pneumatic rubber tires, or WARCO steel or rubber tread rear-type crawlers. We will gladly demonstrate these year around machines.

W. A. RIDDELL COMPANY, BUCYRUS, OHIO

POWER and DRAWN GRADERS — WHEELED SCOOPS — CRAWLERS — MIXER and LEVELER UNIT



See

the JOB through *with* CARBIC LIGHT

WHEN Carbic Flood Lights are part of your equipment, there is no need to fear the penalty clause or the loss of a bonus, if night work can make up for your delays.

Carbic Flood Lights are compact, self-contained, portable lighting units. Rugged and easy to use, they are always dependable for an emergency. They operate equally well in hot or freezing weather, and in wind, rain, hail or sleet.

Carbic Flood Lights are provided with a filter which frees the gas of moisture and solid particles. Maximum brilliancy of the flame and a constant volume of light are assured. All Carbic Flood Light Reflectors are chromium-plated. They are rust-and tarnish-proof.

These advantages of Carbic Flood Lights are further emphasized by the recent price reductions on Carbic, which total in most zones as much as $30 a ton. This greatly lowered fuel cost coupled with low first cost, makes it economical to use Carbic Flood Lights liberally wherever work must continue after sundown.

Sold by leading jobbers everywhere.

CARBIC

PROCESSED CARBIDE FOR CARBIC LIGHTS & GENERATORS

The new low price of Carbic is $6.00 a drum in Zone 1, $6.50 in Zone 2, and $7 in Zone 3. Write for Zone map.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

126 Producing Plants — UCC — 627 Warehouse Stocks

IN CANADA, DOMINION OXYGEN COMPANY, LTD., TORONTO

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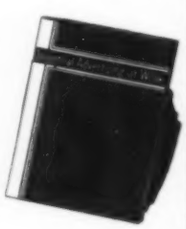
LINDE OXYGEN • PREST-O-LITE ACETYLENE • OXWELD APPARATUS AND SUPPLIES • UNION CARBIDE

*7 Jobs that business paper advertising can do NOW

Just one of ten ways in which business paper advertising can help you get business... today.

★*It can get sales direct—if your product is such that it can be sold without personal contact.*

This and the other uses of business paper advertising are explained in our book, "Industrial Advertising at Work". We will gladly send you a copy on request.



McGRAW-HILL

McGRAW-HILL PUBLISHING CO., Inc., New York · Boston · Philadelphia · Washington

Business men, industrialists and engineers—600,000 of them—regularly read the McGraw-Hill Publications. More than 3,000,000 use McGraw-Hill books and magazines in their business.

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. . . *focused only on* TODAY'S PROSPECTS

In times like these, the one big reason for you to spend money on advertising is to get business. But before you advertise you must first know where your prospects are to be found. Then concentrate your advertising in the publications that go to them most directly.

If you sell to business and industry, McGraw-Hill has simplified this problem for you. The McGraw-Hill business papers are focused only on today's prospects. Their editorial content attracts the active men who are responsible for the buying of business and industry. The result is an exclusive circulation of over half-a-million men—all worth reaching. In a recent survey of executives it was found that 69% not only read their business papers, but also use them as their buying guides!

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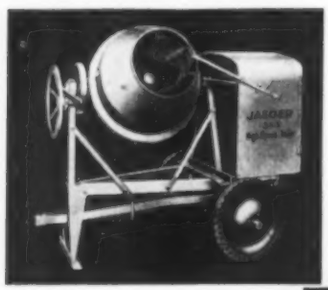
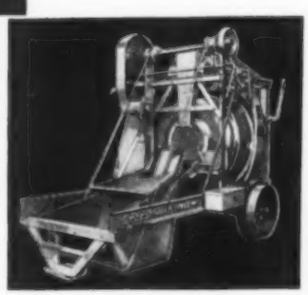
JAEGER *offers* MORE *for* YOUR MONEY---



---in "Dual-Mix" Tilters *at* $169 *up:*

half-bag trailers and 3½S, 7S, 10S power loaders with double the mixing action of any other tilter made.

---in Non-Tilters *that Outperform all Others:* from SPEED KING 7S trailer to 56S, a size and type to fit your job and handle it to best advantage.



---and in Improved PUMPS *at* LOWER PRICES!

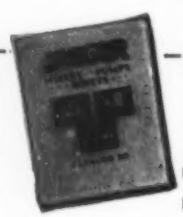
From the 2", 10,000 gallon SPEED BOY Self-Priming Centrifugal ($181, f. o. b. Columbus), Jaeger Pumps offer improved performance at remarkably low prices—an opportunity to save real money on your drainage work this year.

Self-Priming Centrifugals, Convertible Diaphragms (at no extra cost), Plunger Lift and Force, Standard Centrifugals—all sizes.

Attractive prices on Hoists, Placing Equipment

2", 10,000 Gallon Speed Boy

Get this Catalog before Buying



THE JAEGER MACHINE COMPANY,
800 Dublin Ave., Columbus, Ohio

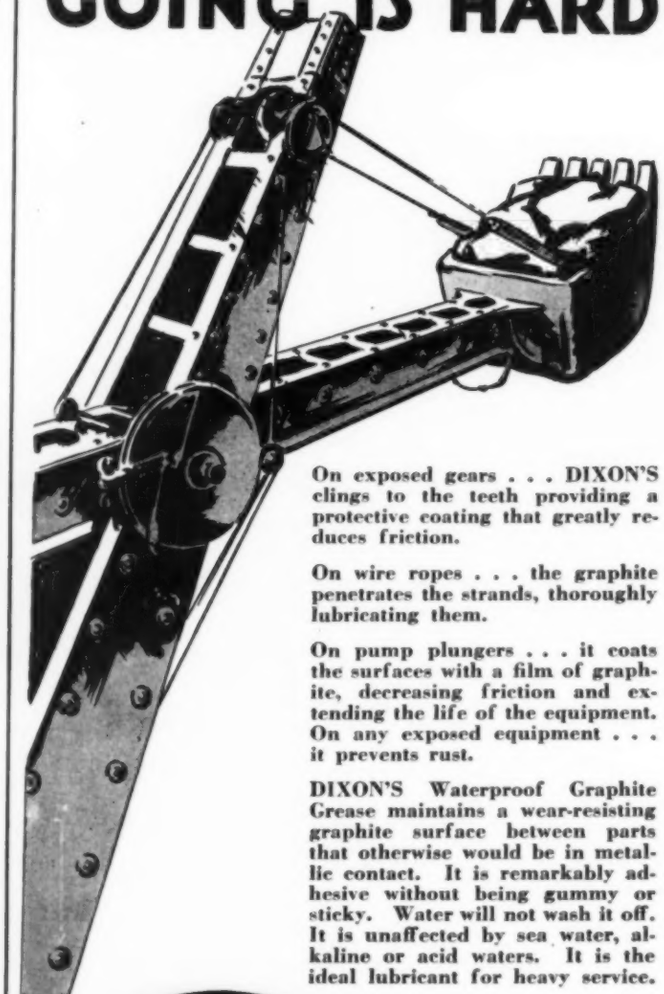
Send latest catalogs and prices on Jaeger ☐ Mixers, ☐ Pumps, ☐ Hoists, ☐ Jaeger-Lakewood Placing Equipment,

Name_____

Address_____

USE IT ANYWHERE

WHERE THE GOING IS HARD



On exposed gears . . . DIXON'S clings to the teeth providing a protective coating that greatly reduces friction.

On wire ropes . . . the graphite penetrates the strands, thoroughly lubricating them.

On pump plungers . . . it coats the surfaces with a film of graphite, decreasing friction and extending the life of the equipment. On any exposed equipment . . . it prevents rust.

DIXON'S Waterproof Graphite Grease maintains a wear-resisting graphite surface between parts that otherwise would be in metallic contact. It is remarkably adhesive without being gummy or sticky. Water will not wash it off. It is unaffected by sea water, alkaline or acid waters. It is the ideal lubricant for heavy service.

DIXON'S WATER-PROOF GRAPHITE GREASE

Other DIXON Products

Flake Graphite
Graphite Seal
Graphite Cup Grease
Pipe Joint Compound
Belt Dressing

Joseph Dixon Crucible Company

Jersey City New Jersey

104 YEARS OF DIXON SERVICE

Built for one job–

Pulling Piles

The Vulcan Piling Extractor is designed for just one purpose—pulling piles. It cannot be used for driving.

But it is always ready to do a quick and economical pulling job. It needs no especial rigging or leads, does not have to be reversed like a double purpose hammer.

Even after the pile is out of the ground, the Vulcan Extractor proves its convenience. Connection to the pile is made through a universal joint which permits the pile to be laid down and disconnected without the usual difficulty.

Designed with but a single moving part, with substantial cross arms and side bars, the Vulcan Extractor gives little trouble under the severest service conditions.

It will frequently pay for itself on a single job.

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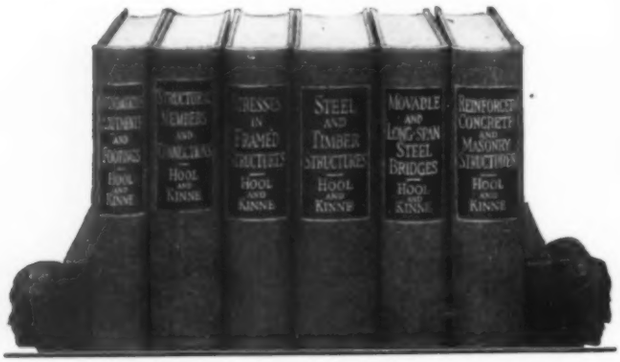

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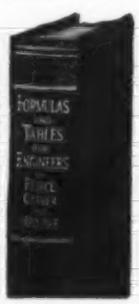

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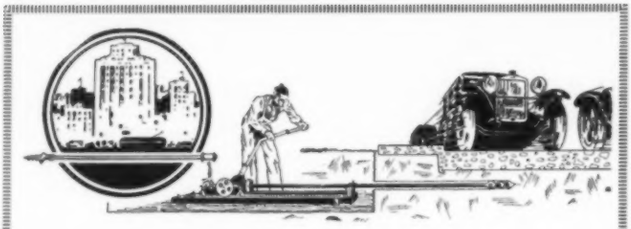

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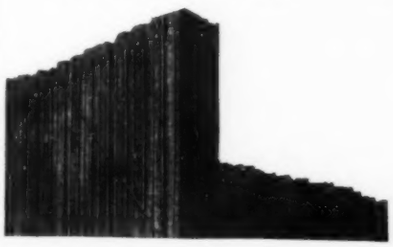

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G-6

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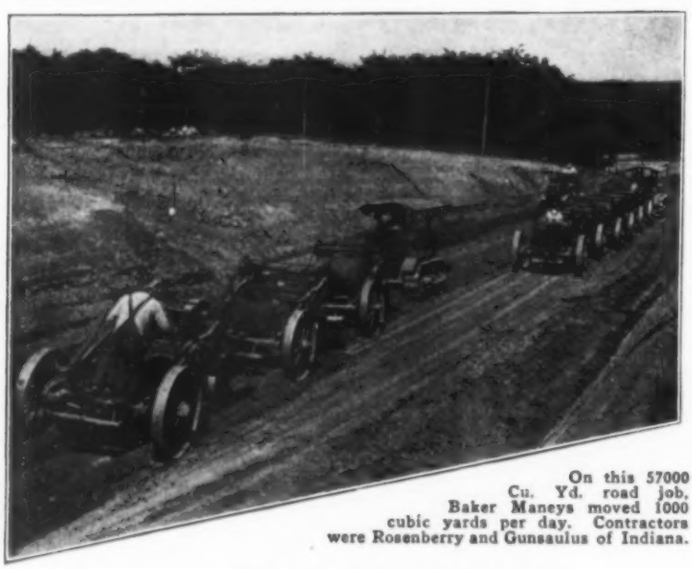

On this 57000 Cu. Yd. road job, Baker Maneys moved 1000 cubic yards per day. Contractors were Rosenberry and Gunsaulus of Indiana.

Send for Facts about Baker Maneys and other Baker Products.

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Cletrac invites you to

VISIT CLEVELAND
during ROAD SHOW WEEK

OPEN HOUSE
at the CLETRAC PLANT

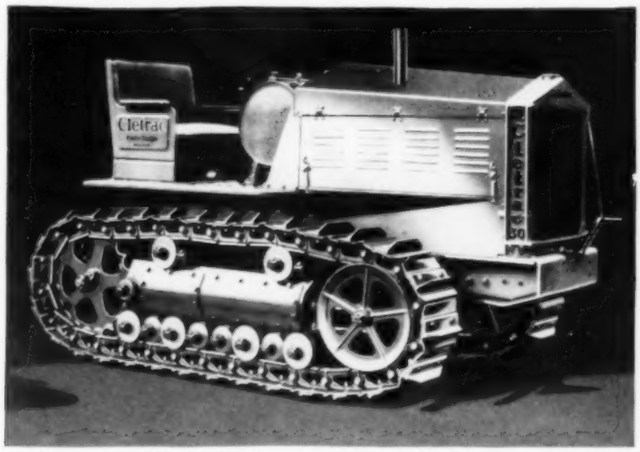
WHEN you go to the road show at Detroit this month, plan a day's stop-over in Cleveland. At the Cletrac plant, OPEN HOUSE has been planned for all of Cletrac's many friends of the A. R. B. A. who can arrange to come — and we promise a day chock full of interest and hospitality. Please consider this your invitation to inspect one of the world's most modern tractor plants and be its guest for a day.

WHEN YOU ARE IN DETROIT, SEE OR PHONE CLETRAC'S REPRESENTATIVE AT THE BOOK-CADILLAC HOTEL, FOR ARANGEMENTS FOR YOUR TRIP TO CLEVELAND

It's a short comfortable ride from the Road Show to Cleveland. You can spend the evening in Detroit and be in Cleveland next morning at the great modern Cletrac plant.

A TRIP YOU'LL ENJOY AND REMEMBER

Nothing will be overlooked to make your visit interesting, pleasurable and profitable. We will welcome the opportunity to have you know us better — to have you see the unusual facilities and resources that are back of the service we offer to you and your industry.



Cletrac's 1932 series of power units brings you the outstanding tractor line-up of the year. In it are five tractor sizes (15 h. p. to 80 h. p.) that cover the entire range of industrial power requirements. And all five models have those modern features of continuous oiling, complete dust-proofing and patented "finger-touch" control that have made Cletracs famous.

Make a note in your date-book now, to visit us in Cleveland. We are sure you will find your visit well worth-while.

CLETRAC
CRAWLER TRACTORS

THE CLEVELAND TRACTOR COMPANY
19323 Euclid Avenue CLEVELAND, OHIO

don't miss it – be sure to COME!

Another thing about DETROIT

(Top) Section of Bagley Street in the heart of Detroit, paved with TEXACO Sheet Asphalt.

(Left) Traffic on Livernois Street, Detroit, rides quietly and smoothly over TEXACO Sheet Asphalt.

(Right) Another Detroit thoroughfare, Lafayette Street, which is paved with TEXACO Asphalt.

You may or may not journey to Detroit, Mich., for the 1932 Road Show.

In either case, there are certain things about this fourth largest city of the United States to interest you. As a paving engineer or contractor, Detroit street paving, particularly, will focus your attention. Traffic rides smoothly and comfortably over Detroit's network of well-kept pavements.

More than half-a-million square yards of this important city's streets are paved with durable, lasting TEXACO Asphalt. This yardage is sufficient to build a fifty-mile 18-foot highway.

More than 1,400 American municipalities today ride over streets paved with TEXACO Asphalt.

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